OCT 8 1909

$4.00 per Year. OCTOBER 7, 1909. Price 10 Cents.

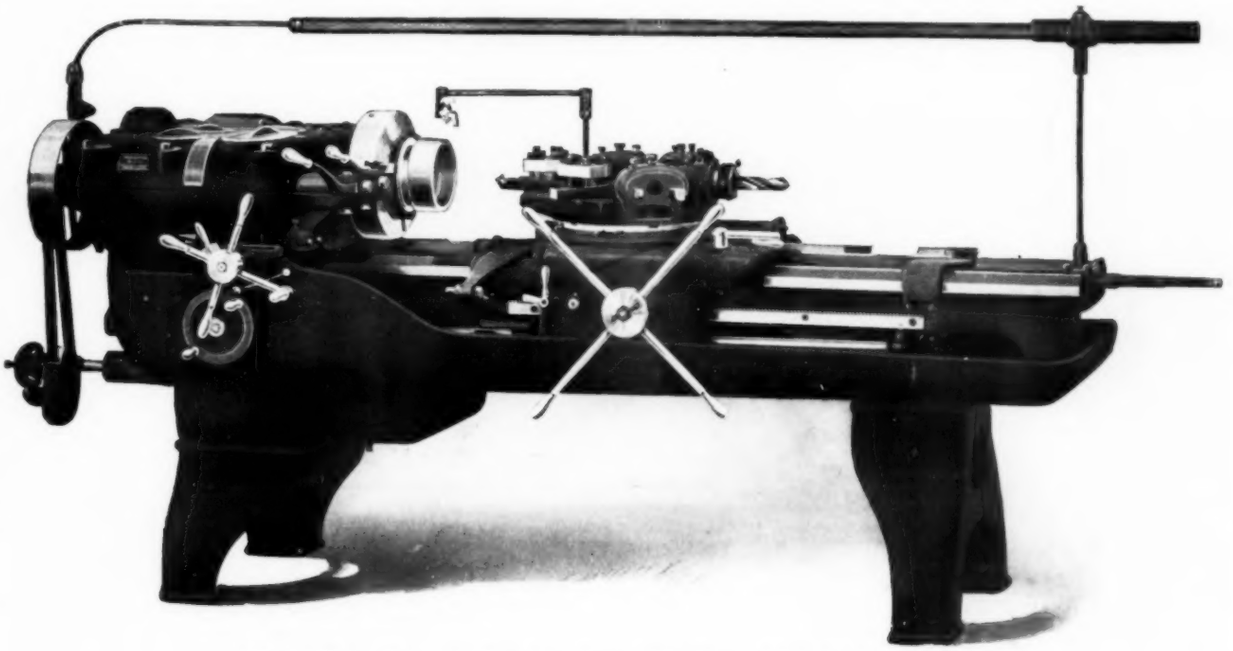
# AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY,

Vol. 32. 505 PEARL STREET, NEW YORK. No. 40.

Index to Advertisers and Classified Index Following Reading Matter.



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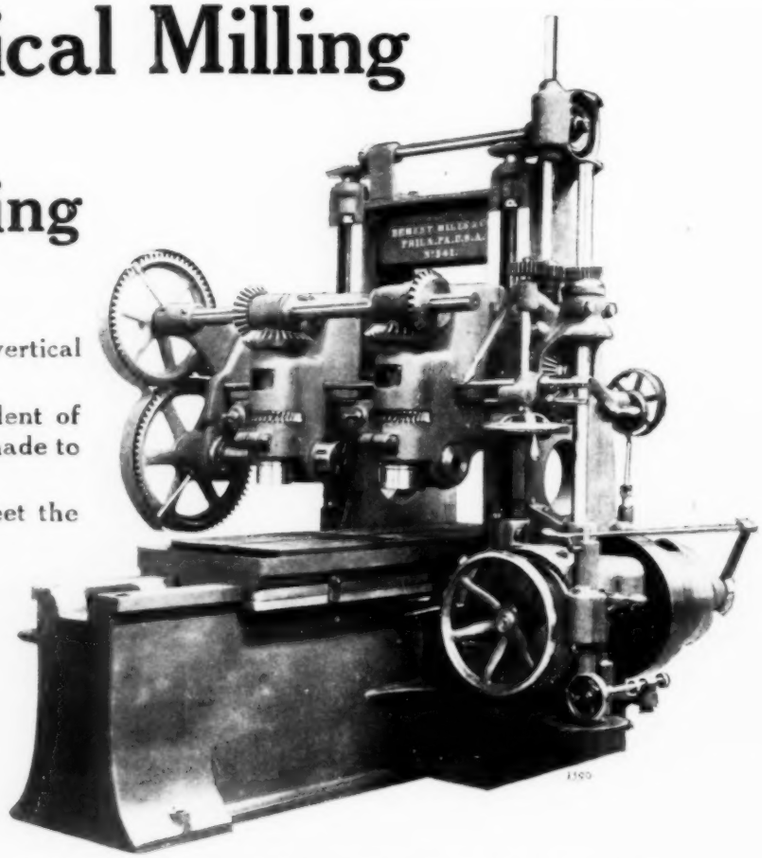

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(*See pages* 51, 52, 53, 54, 55, 56, 57 *and* 58)

# Making Shelby Seamless Steel Tubes

## Automatic Mills Which Transform a Solid Steel Billet into a Seamless Tube. Punches and Dies Which Make Seamless Tubing from Steel Plates

BY R. S. BAYARD

To take a short length of solid round steel billet and automatically roll a hole through the middle of it transforming it into a long slim seamless steel tube would seem to be something like the work of a magician. This operation is, however, of daily occurrence, many thousand times a day in the seamless-tube mills of the National Tube Company, of Pittsburg, in which the accompanying halftone photographs were taken.

There are two main classes of seamless steel tubes, that is, the hot-rolled and cold-drawn. The hot-rolled tubes may be again divided into two main classes; those used for mechanical purposes in machine shops, requiring some degree of machine finish and those tubes which are used as the elements of water-tube steam boilers. The cold-drawn tubes are also used for two main purposes which are the same as for the hot-rolled with the exception that the cold-drawn mechanical tubes used in machine construction are so accurately made to diameter both outside and inside that they are intended to require very little if any further machine treatment before their use as part of a machine. The use of cold-drawn tubes for boilers is becoming more and more prevalent and the United States Government always specifies cold-drawn seamless tubes for the water-tube boilers of modern men-of-war.

The manufacturing of seamless steel tubes is almost entirely automatic and for this reason is of unusual interest as being another example of the use of automatic and semi-automatic machinery in modern manufacture. Seamless brass and copper tubing has been known for some time, but it is only in recent years that seamless steel tubing has been produced. In fact it may be termed one of our newer industries although its growth in popularity has been very rapid.

FIG. 1. THE PIERCING DISKS. MALLEABLE-IRON POINTS AT LEFT AND CONVEYING ARMS AT RIGHT

### The Influence of the Bicycle

Seamless steel tubing was first used in this country for the manufacture of bicycles and it is very largely to the bicycle industry that the introduction and rapid growth of the use of seamless steel tubing is indebted. The trouble encountered in the first attempt at manufacture was the impossibility of obtaining

steel of the proper grade. Steel is a very peculiar material in that so many different grades are possible of production and the characteristics of the different grades may vary through such wide limits. Two steels having practically the same chemical analysis but made by different processes may reveal entirely different characteristics.

Difficulty of obtaining the proper steel for making seamless tubes somewhat delayed the industry in this country, but the great demand for the tubing for bicycle manufacture led to the importation of great quantities of steel from Europe, this being of the proper grade to successfully work into tubes. Even with this imported steel, the first tubes were made by drilling the billet through the center with a machine drill and these short thick-walled tubes were then drawn out into longer lengths. The drilling process, however, was expensive and only the great popularity of the bicycle during the hight of what was known as the "bicycle craze" made it possible to manufacture seamless steel tubing on a commercial basis.

At the present day the seamless tubes are not made by drilling a hole through the billet but by literally rolling a hole through it. The round steel billets in short lengths, say 5 inches in diameter by 2½ feet long, have a small shallow hole drilled in the exact center of one end. This shallow hole acts only as a guide to insure that the piercing of the billet shall be exactly in the center. This is extremely important for any eccentricity will result in a tube having walls of irregular thickness and it is impossible to ever cure such a condition by further manipulation of the tube during its manufacture.

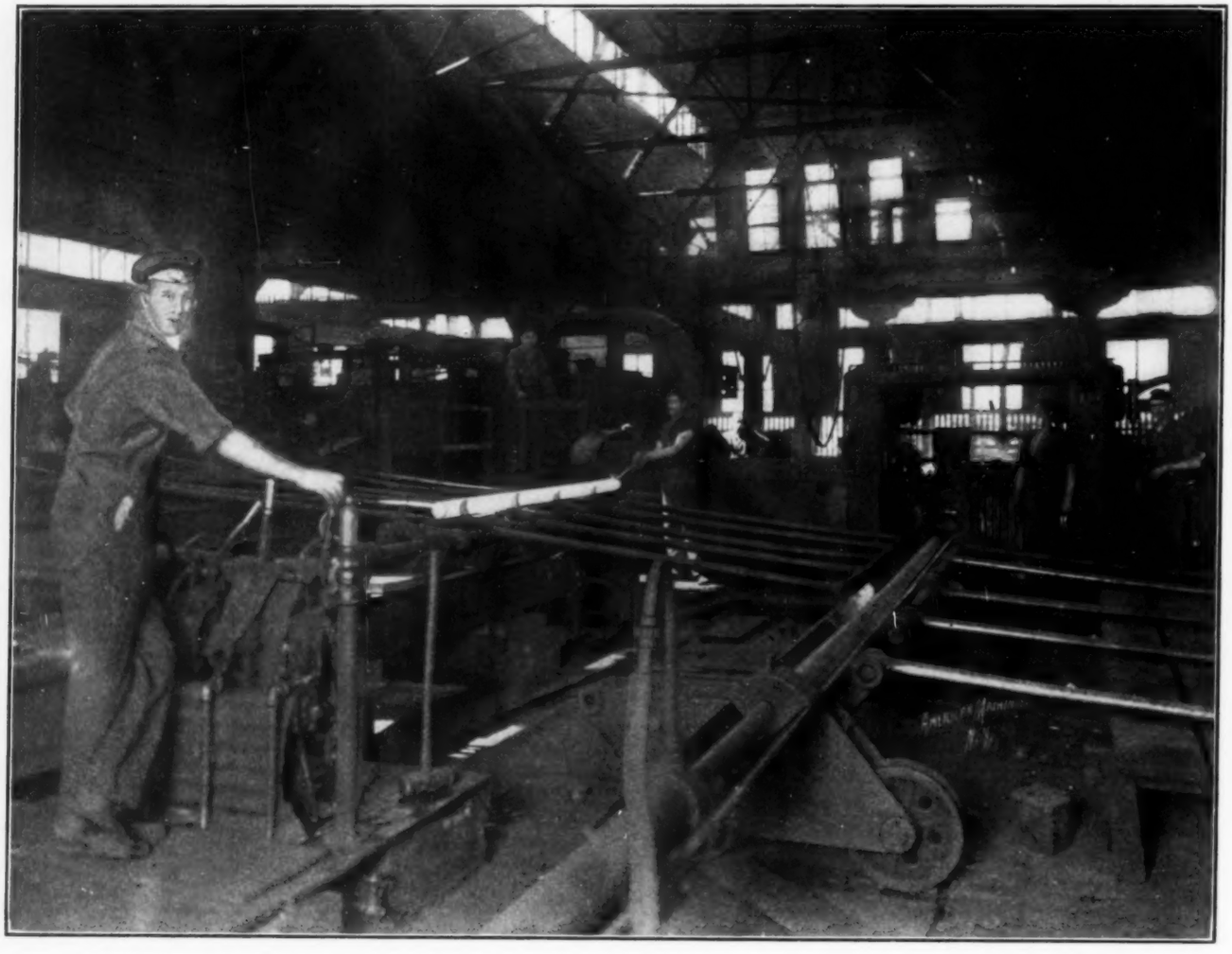


FIG. 2. BRINGING THE WHITE-HOT TUBES TO THE ROLLS. OPERATING LEVERS AT LEFT AND PNEUMATIC RAM AT CENTER

### Rolling a Hole

Centered billets are delivered from the heating furnace at a bright forging heat to a runway which by means of grooved rollers in the bottom forces the billets into the piercing machine. The piercing machine is most interesting and rather difficult to understand, the essential parts being two revolving chilled cast-iron disks.

To describe these disks one may imagine a shaft composed of two lengths fastened together by an ordinary flange coupling of large diameter. Now suppose the bolts are removed from the circumference of the flanged coupling and the bolt holes entirely filled up and eliminated. Next let us imagine the right-hand half of the coupling drawn a little toward the observer swinging the shaft with it about an imaginary center say 10 feet to the right of the coupling. This draws the right-hand half of the shaft out of line with the left-hand half. Now we can imagine the left-hand half of the shaft with its half of the flange coupling to be swung away from the observer to such a position that the two halves of the shaft are parallel with each other but not in the same straight line. This swinging has resulted in bringing opposite sides of the two flanges of the coupling opposite each other. This may further be illustrated by considering two wheels turning side by side but one wheel set a little in front of the other wheel so that their opposite rims revolve beside each other although traveling in opposite directions while the two wheels are each revolving about their own axes in the same direction.

If now a round, hot, steel billet is placed between the faces of the two disks and the two disks are forced along their axes to press against the steel billet as they re-

volve, it will appear that the friction of the disk faces on the billet will cause the latter also to revolve about its own axis, the one disk pushing down on one side of the axis of the billet and the other disk pulling up on the opposite side. If the billet is hot enough and the two disks are forced together against the billet with sufficient force as the disks and the billet revolve at high speed, the peculiar result will be that the center of the billet will begin to crack open, producing a small hole right through the steel.

Such an action can be imagined when the effect of a pening hammer is considered. Pening a metal surface, as is well known, stretches the surface and if this were done hard enough and long enough all over the surface of a round steel bar, it is not difficult to imagine that the pening process tending to make the skin surface of the bar grow larger, would lead to the splitting of the metal through the center of the bar, stretching it out into a cylinder and the diameter of this cylinder would be slightly larger than that of the original bar.

This is the action of the revolving disks on the hot steel billet, but the process is made positive and much quickened by the insertion of a malleable-iron point into the center of the rapidly revolving hot steel billet just where the small guide hole already spoken of was drilled. This malleable-iron point looks very much like a large bullet although its point is sharper. This point is about 8 inches long, as a rule, and is forcibly held in place between the two revolving disks right in the center of the revolving billet by a long steel rod or mandrel which extends back some distance.

Billets are inserted between the revolving disks just below their centers and the direction of rotation of the disks is such that the billet is spirally rolled and drawn into the space between them with great force. The revolution, the pressure and the forward pushing result in shoving the steel billet right over the malleable-iron point on the end of the mandrel rod, the billet stretching out into a seamless steel tube probably six times its original length and of course, with a very considerable sized hole through its center. It would almost seem as if the action of the disks and the malleable iron point is to literally turn the steel billet wrong side out right over the point of the mandrel rod.

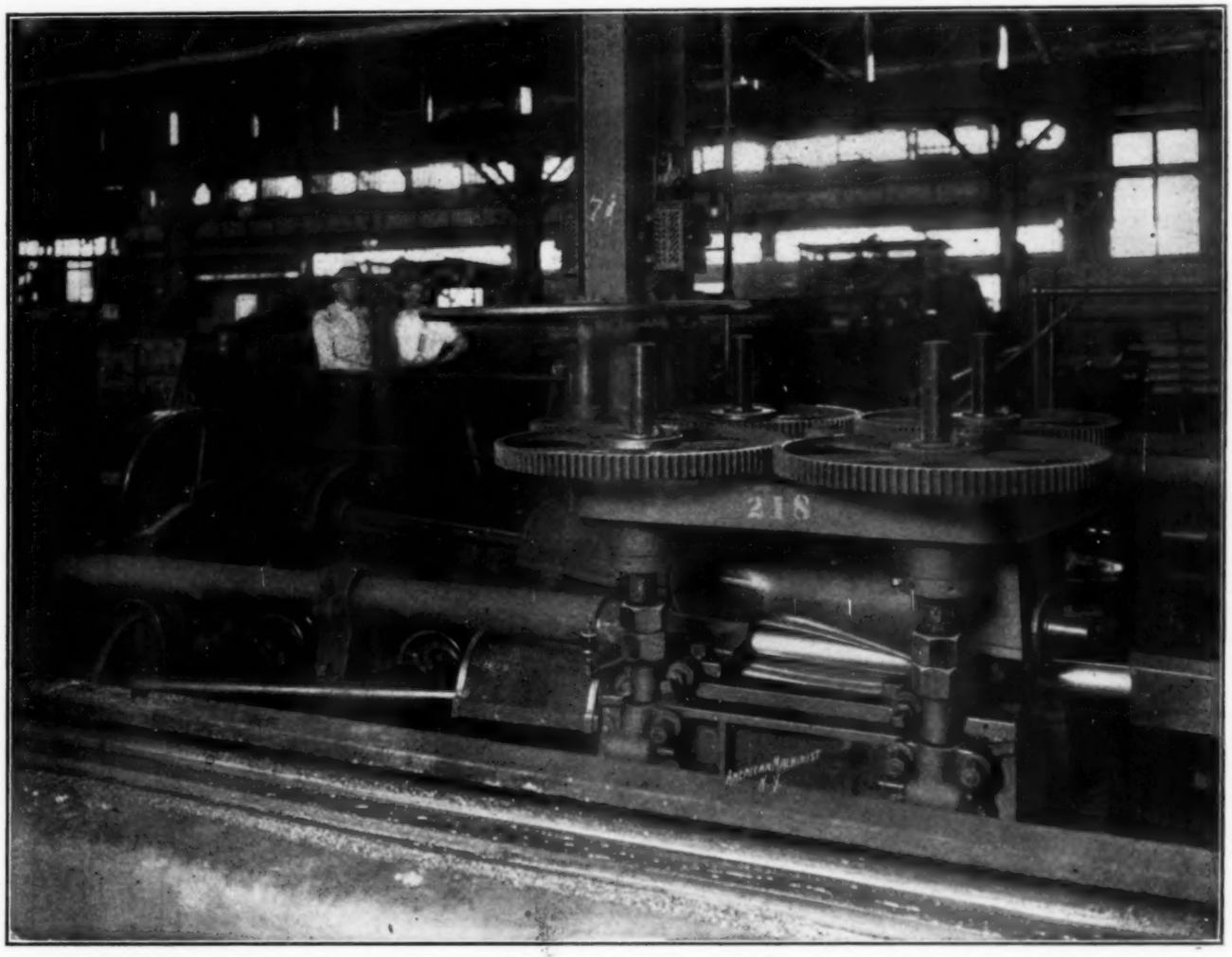


FIG. 3. TUBE PASSING THROUGH THE CONICAL STRAIGHTENING ROLLS

### The Automatic Mills

After this action the now roughly formed seamless tube is forced along the mandrel rod about ten feet inside of a heavy iron casing. An operator working a series of levers in front of him throws pneumatic pressure on a cylinder which opens up the top half of the heavy iron casing, revealing the still brightly red-hot but rather rough tube. Movement of another lever draws back the mandrel rod probably 20 feet, this drawing back being done by means of an electric motor and a couple of steel cables, the mandrel being attached to a sliding head. The mandrel bar is so attached to the head that it is free to revolve on its own axis as the billet rapidly revolves during the process of formation into a tube.

Heavy iron casing over the mandrel rod and the newly formed tube is used for the purpose of protecting the workmen. The pressure is so great that with small diameter tubes necessitating a small diameter mandrel rod, the tremendous vibration while the tube is revolving at high

speed sometimes causes the mandrel rod to buckle and unless the rod and the tube are held by the iron casing, serious injuries might result to those operating the machinery.

After the tube has been forced over the malleable-iron point of the piercing machine and the mandrel bar has been withdrawn, the malleable-iron point will be found to have been left behind in the space between the revolving disks. An attendant reaches in with an iron hook and draws out this point, throwing it into a tank of water. He then picks up a cool point, and by means of the hook thrusts it into the space again between the revolving disks. A reverse motion of the lever controlling the sliding head and the mandrel bar reverses the motor, pushing the mandrel bar back into place, which again holds the new point in position between the disks. The point is so made that it fits over the end of the mandrel bar by a slightly tapered joint on the end of the bar. The tremendous pressure of the billet coming through between the disks assures that the point does not fall off the end of the bar during the time that the billet is being rolled into a tube.

Following the withdrawal of the mandrel rod, the operator moves another pneumatic lever which brings up a row of steel fingers, lifting the newly formed tube out of the casing in which it was resting and rolling it over onto a set of steel arms. The movement of still another lever raises these arms, carrying the tube up into the air about five feet and then allowing it to roll down over the guides to the next process, which is that of rolling out the irregularities in the surface of the tube.

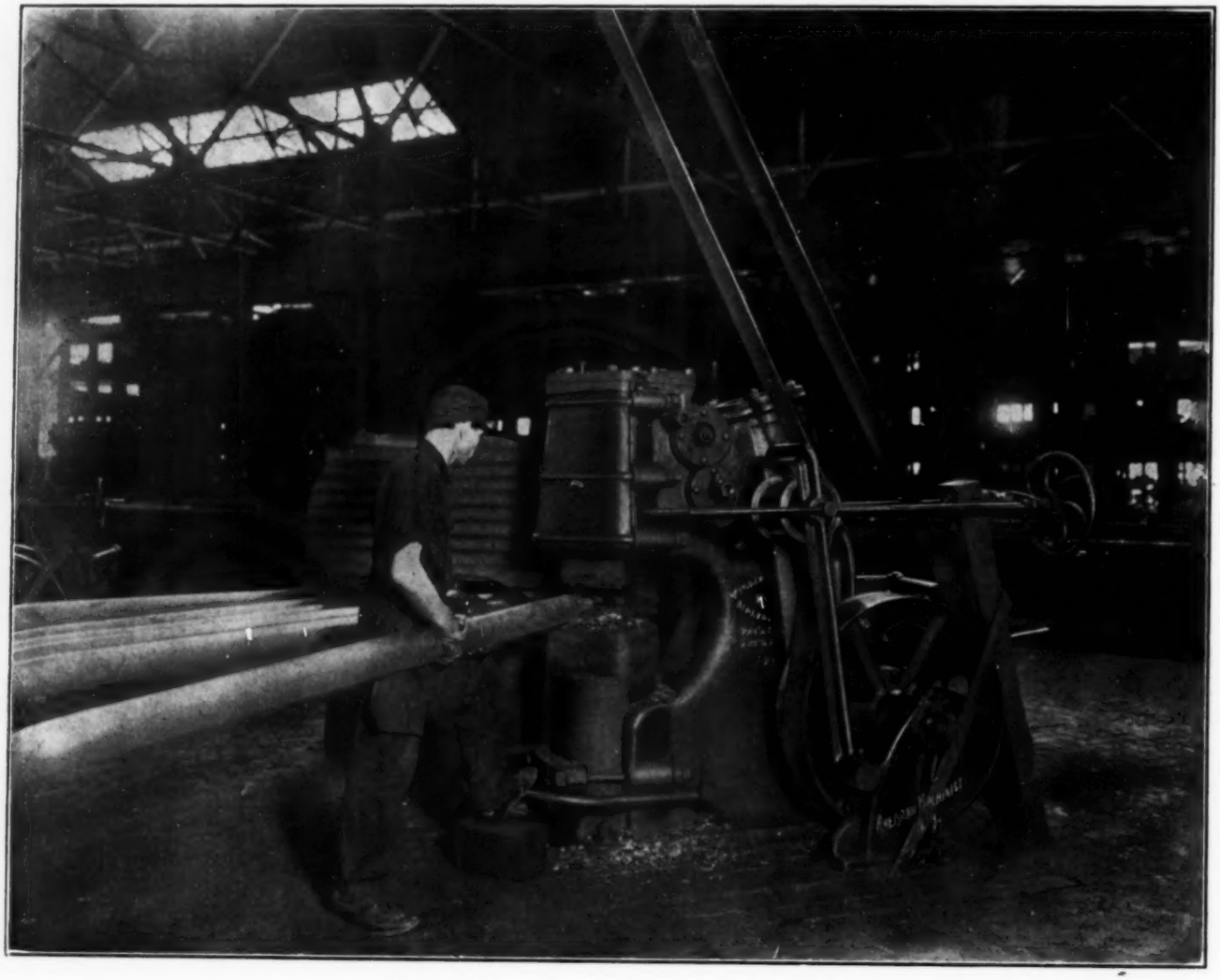


FIG. 4. POINTING THE TUBES BEFORE COLD DRAWING

### SMOOTHING OUT THE SURFACES

In this operation the newly formed and still brightly red-hot tube is delivered to a set of ordinary rolling-mill rolls made of chilled cast iron and which are provided with a series of semi-circular grooves. There being two rolls, the result is a series of round holes between the rolls. Only one pair of grooves is used at a time, but as they wear from constant use the next pair of grooves is used, thus making it possible to keep one pair of rolls in the housing for a considerable length of time, doing away with the necessity of often changing them.

In the center of the round holes between the two rolls is another point, this time being made of cast iron and shaped almost exactly like a large bullet probably 6 inches long. This point as before is held on the end of a long steel mandrel bar which extends back on the opposite side of the rolls. In this case, however, the mandrel bar is rigid, and neither revolves nor is drawn back and forth.

Tubes coming from the arms which carry them from the piercing machine are forced forward by the action of a pneumatic ram sliding along a trough and pushing the tubes in between the revolving rolls. As the tube goes through the rollers, the cast-iron point, of course, passes into the center of the tube, and the action of the rolls is to greatly smooth out the tube surfaces, both by the action of the rolls on the outside and the cast-iron point, or as it is known, the "ball" on the inside. The pressure on the point of the ball is very great, and when next the tube is withdrawn from

the mandrel, it is found that the ball is red hot and considerably worn.

Removal of the tube from the mandrel bar is accomplished through the action of two pneumatic cylinders, which are controlled by a pair of levers in the hands of an operator. The first lever and cylinder slide back a steel wedge in the housings of the rolls, which allows the upper roll to lift up, probably ½ inch, by the action of heavy springs on the top of the housings. The other lever and cylinder bring two auxiliary grooved wheels together so as to bear on the outside surface of the tube as it lies over the mandrel. These wheels revolve in the opposite direction from the rolls and their action is to draw the tube off from the mandrel bar back through the separated main rolls and out on the same side from which it entered. In this way the whole operation is mechanical, and it is not necessary, except for an occasional guiding of the tubes, to manipulate them by hand.

At the rolls another operator with a pair of long tongs reaches into the space between the rolls after the tube has come out, takes out the cast-iron point or ball, throws it into a tank of water, and replaces it with another one. The pneumatic ram comes forward again, forces the tube between the rolls and over the new point, the rolls having been slightly drawn together by an adjusting wheel so as to further reduce the diameter of the tube, and give it a still more even surface both inside and out. Again the rolls are separated, the small ejecting wheels are brought together, again pulling off the tube from the mandrel; the operator reaches in, pulls out the old point and replaces it with another.

FIG. 5. COLD DRAWING A TUBE. POINTED TUBES AT RIGHT

### Heavy Work and Quick Wits

As a rule, these tubes make three passes through the rolls, the operator changing the cast-iron point for each pass. The points last usually for two tubes, and after this one of the three used for the three passes is thrown away and replaced by a brand new one from the foundry. The work of the man who inserts and removes these cast-iron points may well be characterized as strenuous. It would appear that this fellow works about four times as hard as any other attendant in the mills, for, while the others are mainly employed in guiding the material through the automatic devices, and in the operation of the levers which move the automatic devices the man who handles the cast-iron points is not assisted in any way by any mechanical parts of the machinery. The points are fairly heavy, and they are a considerable distance inside of the roll housings, between the two rolls. Furthermore, the bright red-hot tubes are passing close to this man every fifteen seconds or so, making his work of the hottest character.

Aside from the difficulty of this work from the physical standpoint, it is most necessary that this man should keep his wits about him, for if he puts in a worn-out point the tube may be spoiled. If he forgets to change the point, trouble will undoubtedly arise from the point being red-hot to start with when the next pass of the tube takes place. If by any chance he should forget to put in any point at all, his trouble is indeed serious, for the rolls will in that case crush the tube down over the mandrel bar where it will be so tight that it is impossible for the reversing wheels to pull it off and where its grip will become more and more powerful as the tube grows cold and shrinks around

the bar. The only remedy for this almost fatal error is to take out the bar and put it in a long slotting machine, cutting the tube open, bending it apart and thus removing it.

These point men having the difficult and exacting work to do, are replaced every 10 minutes by other men who work with them in alternate spells. Aside from this, these operators are rewarded by considerably higher pay than most of the other operators receive for the easier and less exacting positions.

FIG. 6. A GROUP OF STEEL CUPS FORMED FROM ROUND PLATES

### Rolling Down to Make It Larger

Three passes through the rolls having been accomplished by the tube, it is very much smoother and truer than before, and it is next carried along a trough having revolving rollers in the bottom, to what is known as the reeling machine. In this machine two cylindrical rolls are located side by side. The axes of these rolls, while being parallel when viewed from above, cross each other at a very small angle when viewed from the side. These two rolls revolve in the same direction, and the tube is fed in between them parallel to their axes, as viewed from above and on the same level as the centers of their axes where the axes of the two rolls cross each other.

Between the rolls there is again a cast-iron bullet-shaped point or ball held on the end of a long steel mandrel bar. The tube is forced in between the rolls over the point of the bar and the rotation of the two rolls being in the same direction, it follows that the tube on the bar revolves in the opposite direction, around the cast-iron ball as a center. In this way the two rolls and the tube might be regarded as a set of three friction-drive rollers, the two outside ones turning in the same direction and the center one turning in the opposite direction, and, of course, the tube being much smaller in diameter than the rolls, turns at a very much greater speed than the rolls themselves.

Of course, the two rolls press against the walls of the revolving tube on the outside, this pressure being regulated by means of a large handwheel turned by the operator of the machine. As the cast-iron point or ball inside the tube is of smaller diameter than the tube this results to a certain extent in flattening the tube into an oval, but as all the parts are revolving rapidly, this oval shape also revolves, or rather the material of the oval revolves while the axis of the oval remains stationary. The revolution and the pressure of the rolls against the outside of the tube walls and the walls against the ball on the inside result in thinning out the walls of the tube.

The fact that the axes of the rolls are not quite parallel when viewed in a horizontal direction results in a forcible drawing of the tube between the rolls and over the cast-iron ball in the center, thus spirally rolling or reeling the entire surface of the tube from end to end, both inside and outside. This is something like the process of rolling steel locomotive tires, and the peculiar thing is that the greater the pressure of the rolls against the tube, the larger the diameter of the tube becomes, because the walls become thinner.

Operation of the reeling machine is facilitated by a very ingenious device. The rolls themselves are driven by a powerful electric motor, and the current in going to this motor passes through an ammeter which is on the housing of the reeler. As the tube comes through the machine, the operator squeezes down on the rolls by means of the handwheel, and the pressure which he exerts is almost directly measured by the power of the motor, and the power of the motor is easily observed by the reading of the ammeter. The operator then aims to so adjust the pressure of the rolls against the tube that the ammeter shows the same flow of current for each tube of a given size. By adjusting the roll pressure quickly any irregularities in the thickness of the tube are corrected as the tube goes through, simply following up the ammeter

FIG. 7. FORCING WHITE-HOT STEEL CUP THROUGH A SERIES OF DIES TO FORM A TUBE

reading during the passage of the tube by a slight turn of the handwheel one way or the other. In this way a very uniform tube is produced.

Correct readings of the ammeter are determined by using a gage to go over the outside of the tube, and every three or four tubes the operator tries this gage. If the gage fits, he knows that everything is all right. If, however, there comes a tube which is too small, and the operator knows that his ammeter reading was the same as usual, giving the correct wall thickness, the only interpretation is that the cast-iron ball or point in the center on the end of the mandrel bar is worn out. He then quickly reaches in with a hook, pulls out the worn point and replaces it with a brand-new one. This point will last for a considerable number of tubes, as the wear on them is not nearly so great as on either of the other two machines using these point centers.

As before, the point in the reeler is held in place by a long mandrel bar, this bar being controlled by the usual sliding head operated by cables from an electric motor. All of these bars are run back and forth simply by the operation of an electric reversing switch, but they are held in place against the heavy thrust of the metal forced over them by a latch which automatically locks the bar in place and which is released by the operation of another lever.

FIG. 8. CLOSED TUBES FORMED FROM CUPS

### Getting the Outside Diameter

After passing once through the reeler the mandrel bar is withdrawn and the attendant, moving a small pneumatic lever, operates a pneumatic cylinder which lifts up another set of steel fingers, throwing the tube over into a runway which draws it in between a pair of slowly revolving sizing rolls. These rolls have two sets of grooves and by their operation the exact outside diameter is given to the tube which it is intended to have. The tube is rolled in one direction through one groove and then by the reversal of the electric motor driving the rolls it is rolled back through the finishing groove of the rolls and down a conveyer to the straightening rolls.

### Straightening

In the straightener the rolls are placed one above the other and, viewed in a horizontal direction, their axes are parallel. Viewed in a vertical direction it will be found that the axes cross each other at an angle of probably 15 degrees. The surfaces of the rolls are not cylindrical. Each roll is the shape of a pair of modified cones facing each other at the pointed ends. They do not come down to an actual point, but the diameter in the center is much less than that at the ends, crudely resembling an hour glass with the exception that the surfaces are depressed and not spherical, as is the case with the hour glass. The cone surfaces are of sufficient angularity and are set close enough together to really lap over each other.

Tubes which are passed through these rolls are fed between them at such an angle as to bisect the angle between the axes of the rolls. The rolls are spaced at such a distance that when the tube lies along between them it touches both rolls at the same time over a length equal to the length of the rolls. As the rolls revolve in the same relative direction, their action upon the tube between them is to revolve the tube on its own axis in the opposite direction. In other words, the straightening rolls are an exaggeration of the reeling machine, and the surfaces of the rolls being conical insure a long line of contact which results in turning out a tube which is almost exactly straight.

From the straightening rolls the tubes slide out into another one of the heavy iron casings which it should have been said are provided also on the reelers. There is no cast-iron point provided in the straightening rolls nor in the sizing rolls, as the inside diameter produced by the revolution of the ball point inside the reeler, giving the correct wall thickness to the tube, should be correct when the correct outside diameter is given to the tube by the sizing rolls.

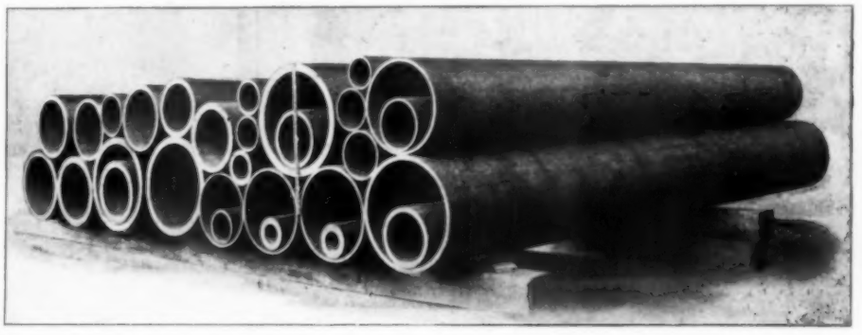


FIG. 9. LARGE HOT DRAWN SEAMLESS TUBES MADE BY CUPPING PROCESS

Passing from the straightening rolls into the heavy iron casing the operation of moving another lever opens the casing and a pair of fingers lift the tube out onto a slowly traveling chain conveyer which gradually rolls it up an incline known as the hot bed. Here the tubes gradually cool off, being delivered at the far end at such a temperature as to be easily touched with the hand.

This process completes the making of seamless hot-drawn tubes. If the tubes are to be used for boilers they are next tested by hydrostatic pressure, after having been cut to length in a cutting-off lathe.

### Cold-drawn Tubes

For the making of cold-drawn tubes the process described is gone through up to and including the reeling machine. As the finishing size is given on the cold-draw bench there is no necessity for passing the tubes through the finishing rolls, or through the straightening rolls. Consequently they are carried directly from the reeler by the crane to the cold-draw benches.

Cold-draw benches are long, rigid, cast-iron tables in the center of which is supported a hardened-steel die. On one side of the die is a very heavy chain belt which is continuously carried along the surface of the table at slow speed by a sprocket at the end of the table. The sprocket is

driven by a large gear and pinion from a countershaft which is in turn driven by a steam engine.

On the end of the bench opposite to the chain is a long steel rod, which is held at the far end in a socket. This socket allows the rod to be pushed back a couple of feet, while when drawn forward the front end, which carries a hardened-steel ball, is held just exactly in the center of the hardened-steel die.

Running on rails on the chain end of the table is a heavy cast-iron car. This car is provided with a pair of very heavy hooks which may be dropped down to engage the slowly traveling link belt. On the front of this car is a pair of heavy steel jaws which are controlled by a lever on top of the car.

Before the tubes are brought to these draw benches they go through the operation of pointing; that is, they are heated on one end for a length of about 8 or 10 inches and are then swaged or mashed down to a rough point under pneumatic hammers. The object of this point is to allow the tubes being pushed through the steel die on the draw bench for a short distance, and then gripped on the far side by the heavy jaws of the traveling car.

To put the tubes into the draw bench the long bar holding the steel ball which is, of course, slightly smaller in diameter than the inside of the the undrawn tube, is slid back so that the ball comes away from the die and then the tube is shoved back over the bar to its full length. It is then drawn forward so that its swaged point projects through the die and is gripped by the jaws of the car on the other side. The long bar with the ball is drawn forward so that the ball is exactly in the center of the die, and then by the operation of a lever on the car the heavy hooks are thrust down into the links of the chain and drawn slowly away from the die holding rigidly in its heavy jaws the pointed end of the tube.

The die is, of course, slightly less in diameter than the outside of the tube which is drawn through it, and this cold drawing by the heavy chain results in slightly decreasing the diameter of the tube and drawing it out in length. This produces a very smooth surface which is accurate in outside diameter to the diameter of the die and in inside diameter to the diameter of the ball which is held on the end of the long rod.

### Pickling and "Doping"

To facilitate the drawing of these cold tubes two things are necessary: First, they are pickled in weak, hot, sulphuric acid to remove the scale produced in the hot-rolling process, and then, after being rinsed, are dipped into a hot solution of water and tallow. This tallow acts as a lubricant both on the inside and outside surfaces of the tube as it is drawn through the die.

Before finishing, the cold-drawn tube has to pass through a large number of dies, sometimes there being 20 or more. Between each two passes the tubes are carefully annealed in gas-heated furnaces to remove the crystallization which is produced by the cold-drawing process. After being annealed the scale is again removed by pickling and then they are again lubricated by dipping into the tallow solution.

To the uninitiated the cold-drawing process is particularly distasteful, for as the tubes are drawn they warm up considerably by the heavy work being done upon them and this warming produces a most disagreeable and sickening odor from the tallow. It is rather a curious fact that the tallow barrels are marked "prime tallow, inedible." After being in the cold-draw department for a few moments it is difficult for the novice to imagine anyone having appetite to eat any kind of food again, to say nothing of the most uninviting-looking stuff that comes from these barrels. The

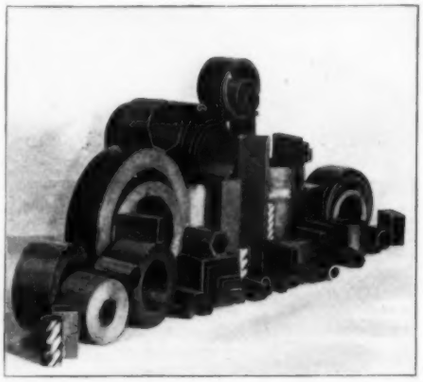


FIG. 10. SOME OF THE MANY DIFFERENT SHAPES OF SEAMLESS TUBING

work is very dirty, as everything becomes smeared with the stiff, bad-smelling grease.

### Odd Shapes

Not only are round tubes produced by this cold-drawing process, but also different shapes, ovals, rectangles, squares, hexagons, octagons, etc., are made from the round tubes by drawing them through other dies designed to give the shape desired. One highly interesting die for making square tubes is different from most dies in that the four side surfaces are formed by four hardened-steel rollers of large size. These rollers, whose axes are all in the same plane, are so set that their rim surfaces form the sides of a hollow square through which the round tube is drawn to make it into a square tube. These rollers do away with excessive friction which would be produced in drawing tubes of large size from circular to square shape. The rim surfaces of the rollers are not quite flat, but are very slightly hollowed. If they were not hollowed the tendency of the flat surface would be to push the metal of the tube down at the sides so that the tube would have sagging sides projecting inward instead of being a true square.

Another interesting and important feature of the dies is that the curvature and taper of their operating surfaces has to be accurately determined. If the taper is too gradual the tendency is to crowd the metal into the die, resulting either in breaking the die or tearing the tube apart. If the taper of the die is too blunt the tendency is to push the skin surface of the metal back along the tube, again resulting in pulling the tube apart. There is a shape which is just between these two, which results in properly drawing the tube, reducing its diameter gradually as desired.

### Tubes from Flat Plates

For seamless tubes up to 5½ inches in diameter the process already described is satisfactory, but for sizes greater than this the tubes are formed from plates. The first process of forming a tube from a plate is to place the plate in a powerful punch which punches out a disk of steel sometimes as great as five feet in diameter. These plates are also sometimes 2½ inches thick. Punching is done hot.

After punching, the plates are reheated and then placed over a circular die through which, by very heavy hydrostatic pressure a blunt-pointed ram is forced, crumpling the red-hot steel plate down into a shallow cup or bowl. The steel flows with the action of the die and the punch, and any crumbled appearance in the surface which might be expected is almost entirely eliminated. These half-formed cups are again reheated and forced through a second die which draws them up into a short cylinder closed at the bottom end by a hemispherical head.

Having been formed into these cylindrical cups they are again reheated and are next slid over the end of a large cast-iron plunger, which has a travel of about 20 feet, this plunger being operated by a hydraulic cylinder. The plunger is so arranged that it may be swung out from its framework by means of a small hydraulic cylinder so as to receive the hot steel cup. It is then swung back again and by the application of the hydrostatic pressure the plunger and the cup are forced forward through a series of six or eight dies, each die being slightly smaller in diameter than the one next preceding it. In this way in one operation the cup is transformed into a long steel cylinder still closed at one end, but much reduced in diameter and, if desired, also in thickness of wall.

This process is repeated after reheating, the cylinders growing longer and longer and smaller and smaller in diameter, until the correct desired dimensions are obtained.

It is by this process that carbonic-acid

gas cylinders are made. The seamless cylindrical tubes, still closed at one end, are swaged down to a bottle neck at the other end, to which the screw cap is finally attached.

In sizes under 8½ inches in diameter the hot-drawn tubes may again be cold drawn on the cold-draw benches to produce the accurate, smooth-finished cold-drawn tubes.

There is a peculiar condition observed in the first cupping process. If by any accident the hydraulic punch or plunger does not strike the exact center of the circular plate the rim of the cup produced will have a small depression in the edge upon one side. It has been found that if this cup is allowed to go through the process in this shape it will result in a long tear in the side of the tube. This will extend for a foot or more, rendering so much material of the tube absolutely useless.

Each operation of reducing the diameter and increasing the length of the cylinder increases the length of this tear, so that it is of great importance to eliminate this condition. When a small depression is observed in the first cup it is customary to take the defective piece to a lathe and there turn off a small portion of the end of the cylinder so that it is perfectly flat and exactly square to the axis of the cylinder. Although this seems peculiar and is difficult to understand, turning off of the defective pieces entirely removes the tendency to form the tear in the side of the tube, thus obtaining the greatest efficiency for a given amount of material.

In drawing out the cylinders into tubes by pushing them through the succession of dies, if the plunger is smaller than the inside diameter of the cylinder the die will result simply in reducing the outside and inside diameters of the tube without reducing the thickness of the wall. If, however, the plunger fits the inside of the cylinder the operation of pushing through a die will result in reducing the thickness of the wall and consequently the outside diameter, but without reducing the inside diameter. By the use of proper dies and plungers it is then possible to work these steel cups into tubes having almost any diameter or thickness of wall. So much for the process of manufacture. Now for the uses of this seamless steel tubing.

### Uses of Shelby Seamless Tubes

It is possible by proper heat treatment to give these tubes varying degrees of anneal so that they may be made stiff and comparatively hard or softer and more easily worked. By what is known as soft annealing they may be very easily bent into various shapes, this quality being especially valuable in the making of tubes for water-tube boilers.

Cold-drawn tubes are furnished to accurate dimensions both inside and out, and for some things, such as bushings, lathe spindles, hollow axles, shafting, and like pieces, little if any finish is necessary. Sometimes a very slight ground finish is given so as to give a better wearing surface. When machine work is necessary on these seamless tubes it is just as well to use the hot-rolled tubes, because the advantage of accurate dimensions in the tube itself is entirely lost if any material is to be cut from it before using.

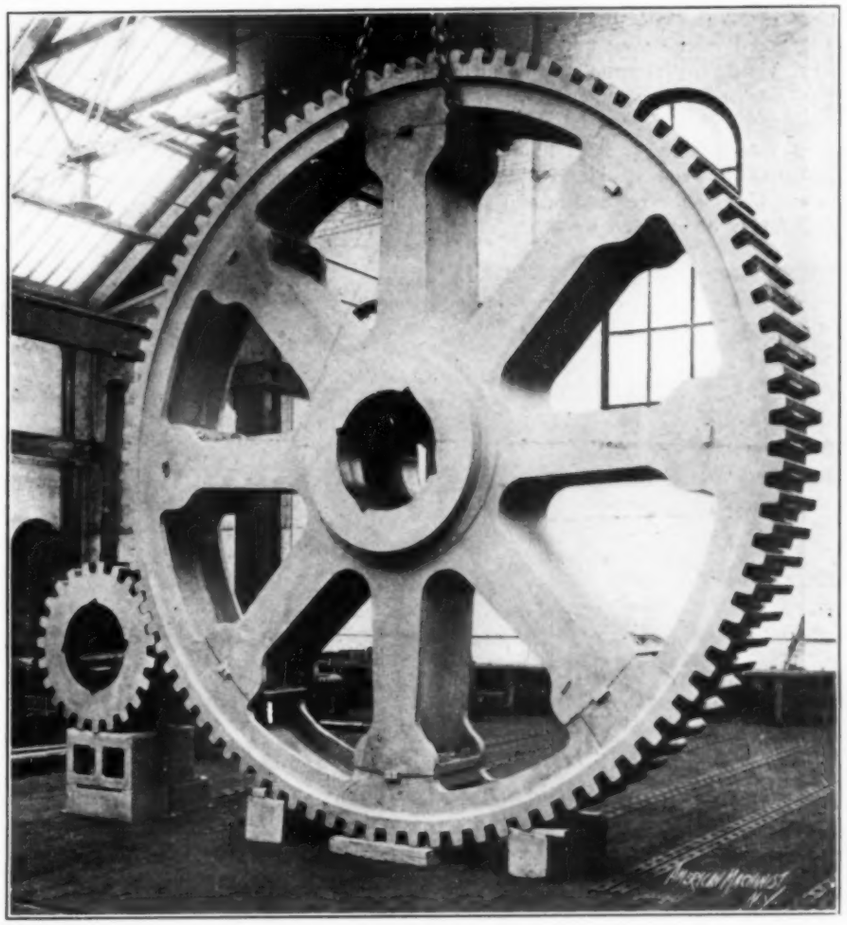
Tubes for mechanical purposes serve almost innumerable uses. Automobile builders employ them extensively. By forging under hammers they may be tapered or flared into flanges, or made into almost any conceivable shape, which lends them a special adaptability for the making of hollow automobile axles. For work requiring special strength and stiffness this tubing is also made with 3½ per cent. nickel. In fact, an idea of the wide uses to which this tubing is applicable may be obtained when it is said that its field stretches from hypodermic needles, artificial legs and cream separators to air ships, boiler tubes and locomotive bushings.

## A Large English Spur Gear

By Frank C. Perkins

The accompanying illustration shows an enormous spur gear weighing nearly 40 tons constructed at Guide Bridge near Manchester, England, at the works of Scott & Hodgson, Ltd.

This gear has a cast-iron center and steel rim, each of which was cast in one piece. The forged pinion, 4 feet 3¼ inches in diameter, will be noted at the left in the illustration. This steel pinion was cut from a solid forging; the teeth of both rim and pinion were milled to correct shape and pitch by special machinery capable of dealing with wheels up to 26 feet in diameter and of any weight.



A LARGE ENGLISH SPUR GEAR

The wheel has a cast-iron center which weighs 18 tons while the cast-steel rim measures 17 feet 3¼ inches in diameter and weighs without the center 21 tons. The method of fastening rim and center together by bolting and keying can be seen in the illustration. The face is 30 inches and pitch 7 inches. Over 50,000 horsepower of heavy cut gearing now running in England has been machined at this Manchester plant.

# Details of the Antoinette Monoplane

## In One of These Machines Latham Made a Record for Long Distance and Duration Flying at Rheims That Was Exceeded Only by Farman

BY AGUSTUS POST*

The "Antoinette" monoplane is the invention of León Levavasseur, the technical director of the Société Antoinette, France. León Levavasseur was born at Cherbourg on January 8, 1863. He himself says: "I dreamed at the age of 14 that I could make an aëroplane and it is now 30 years later that I realize my youthful idea."

In 1903 he experimented with and built the "Ferber-Levavasseur" machine, and afterward with the financial assistance of M. J. Gastambide, he built a monoplane known as the "Gastambide-Mengin" aëroplane. During the researches and studies preparatory to the construction of this monoplane "Antoinette" No. V, which was a new and distinct type from the machines built by the Wrights, Santos-Dumont and Voisin, which were all biplanes.

M. Lavavasseur considered that the monoplane offered the advantages of simplicity of form, natural stability, and was easier to construct; that is to say, that the thrust of the motor required for flight was less under the same conditions of speed and weight.

The "Antoinette" is particularly interesting on account of the manner in which the problems have been studied and the great amount of thought that has been given to them. The machine is perhaps without question the most finely finished of those in its class, shows the most careful workmanship in its most minute detail, and presents more new and original features than any of the other machines which may be compared with it. It also provides a comfortable cockpit for the aviator, a distinct advantage in long and trying flights.

M. Lavavasseur is undoubtedly a genius in the designing of aëronautical apparatus, whether engines or flying machines. Personally, he is a man of peculiar charm of manner, thoroughly convincing, courteous though bluff, and with a keen sense of humor; he inspires confidence in all who meet him.

The "Antoinette" is built on the plan of a triangle. The wings form a wide triangle, the tail in the rear is triangular and the framework itself forms a triangle. As Captain Ferber aptly says, "It forms a V, transversely, longitudinally and horizontally."

In time of calm, the center of pressure is equal to each wing, and as they are placed so as to form a slight dihedral angle the center of gravity comes under the center of support and effects lateral stability. The size and length of the tail causes the machine to keep a constant angle of incidence and tends to keep it steady in its path of flight. Mr. Latham like M. Blériot, has occasionally let go of the controls altogether, and even taken time to roll a cigarette, so perfectly is this machine balanced. At Rheims when the other machines were continually pitching and undulating with the irregularities of the wind the "Antoinette" gave the impression of stability which has been sought for and obtained.

The "Antoinette" captivated the spectators at Rheims by its beauty. See Fig. 1.

It certainly seemed to realize automatic equilibrium, and by its accomplishments as

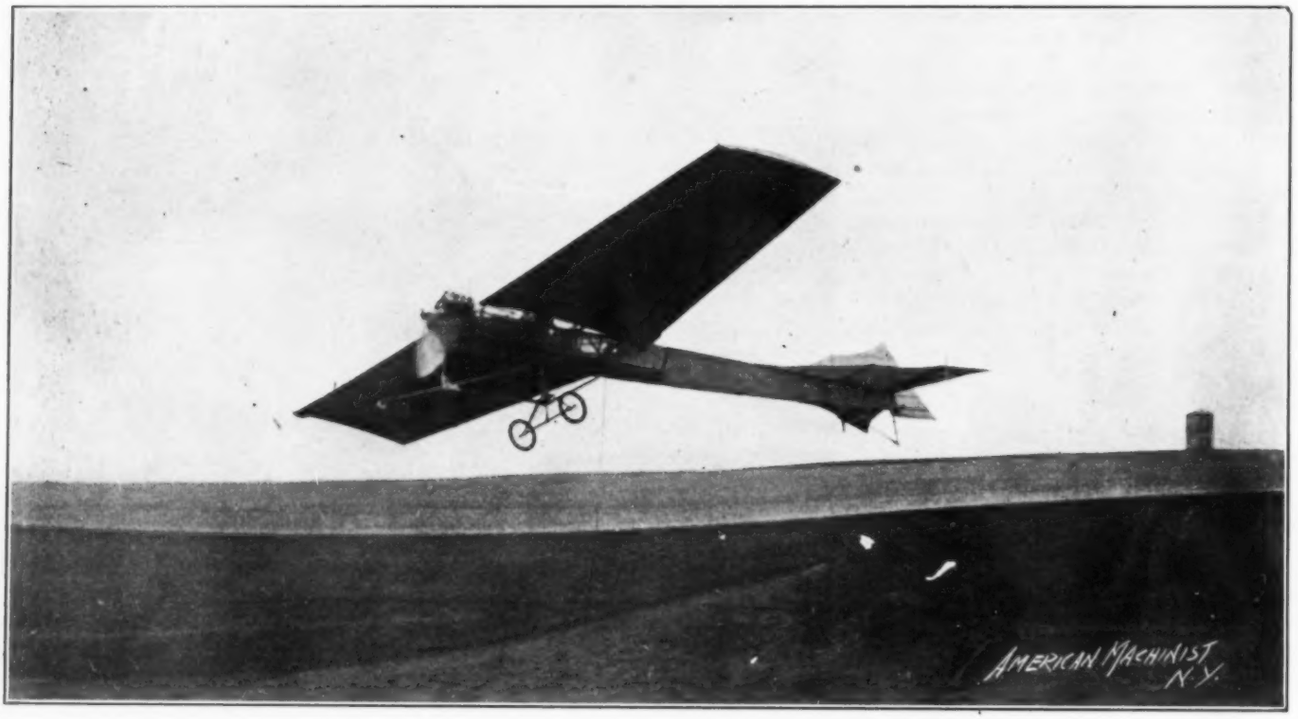



FIG. 1. "ANTOINETTE" MONOPLANE IN FLIGHT AT RHEIMS

machine, the famous and extremely light flying-machine motor known as the "Antoinette" was invented and developed to a high degree of perfection. This motor, by its lightness, made possible the first mechanical flights in France which were made by Santos-Dumont, Farman, Delagrange and Blériot. It was also used in motor boats and had great success in the races at Monaco.

The motor having been perfected, attention was turned to the construction of a complete flying machine, and in 1908 the Société Antoinette started to build the

*Secretary, Aëro Club of America.

well as by its form and elegance, it was actually the "Chef-d'œuvre" of the constructors.

### General Features

M. Levavasseur, the son of an officer of the navy, has built his bird like a boat. It glides through the air very easily and safely when the motor is stopped. The supporting surfaces show a very constant ratio between the lift and the drift at a great variety of angles of inclination, as has been shown by investigations made in the aërodynamical laboratory of M. Rateau established by the French Society for the Study of Aërial Locomotion.

The wings are two in number, symmetrical, and of trapezoidal shape, their base joins the body of the machine; the wings are set at a slight dihedral angle forming a very broad V when looked at from the front. They have a spread of 12 meters 80 centimeters (42 feet). See Fig. 2. Both sides of the wings are covered with varnished cotton, pumiced, which gives them a remarkable polish and a very small coefficient of friction, and allows them to glide easily through the air.

The surface of each wing is 25 square meters (269 square feet) and their angle of incidence is 4 degrees. Their framework consists of a girder form of structure composed of longitudinal and transverse ribs which cross each other and are braced to each other by small pieces which form triangles; this renders the entire wing framework perfectly stiff. It is the same construction based on the pyramid and triangle that is used in the iron work of the Eiffel Tower, and it resists stresses and strains in all directions, giving a rigidity and firmness to the wings with the greatest lightness possible.

The builders have been able to make the wings of 25 square meters surface (269 square feet), which do not weigh more than 25 to 30 kilograms (55 to 66 pounds) without the covering or about 1 kilogram (2.2 pounds) per square meter.

The wings of Mr. Latham's machine No. IV, with which he made his first attempt to cross the English channel, were made water-tight so that they held air in the space between the upper and lower surfaces of each wing. This was done so that they might serve to float the aëroplane, should it descend while over the water, and when such a descent actually happened, it proved the salvation of the machine, and contributed materially to the safety of the pilot.

### The "Antoinette" IV

The "Antoinette" IV is purely a racing machine. It is somewhat smaller and has in all 300 square feet of supporting surface against the 370 square feet of the "Antoinette" V and VI. It is also a faster machine. The forward parts are the same, but the arrangement of the tail differs somewhat, as is explained later. The spread of the wings is 40 feet, the overall length 37 feet, it weighs 1000 pounds, and the propeller is 7 feet in diameter. It is stated that when the motor was brought back to Sangatte after its first attempt to cross the English channel, a small wire was found to have got into the distributor and short-circuited the ignition.

Mr. Latham made his next attempt with the No. VII and nearly succeeded in reaching Dover, lacking only about one mile of reaching the English coast. This machine is very similar to "Antoinette" Nos. V and VI, but it is larger and a little slower than No. IV; it has 36 square meters (388 square feet) of surface, a longer body, larger tail planes, and warpable main surfaces covered with rubberized cloth manufactured by Michelin. After the motor stopped the manner in which the machines glided down to the surface of the water and alighted, showed how stable they are as gliders. The control is also good, which allowed the machine to strike the water at just the right angle, so as not to pitch downward.

*The body* of the "Antoinette," 9 meters (28.8 feet) in length, is built like the hull of a boat with a triangular cross-section; it has a stem in front in which the motor and propeller are placed and to which the wings are attached. The mast, from which guy wires extend to brace the wings, is also placed in the center of the body between the wings. Behind the motor and main wings is located the cock pit for the aviator.

The body becomes progressively smaller toward the rear and has the same girder form of construction that is used in the wings.

### The Tail

The rear extremity of the framework of the body carries the horizontal and vertical tail surfaces like the feathers of an arrow.

Hinged to the rear edge of the horizontal surfaces are the horizontal rudders made in duplicate, and placed one on each side of the vertical surface used in steering the machine up or down in a vertical direction. It will be noticed that these rudders form a prolongation of the horizontal surfaces of the tail; See Fig. 4. The vertical rudder for steering to the right or left in a horizontal plane is, in the No. V machine, a hinged section of the vertical surface in the upper side of the tail. This arrangement was different, however, in the machine No. IV used by Mr. Latham in his attempt to cross the English channel, and in that machine the vertical rudders were in duplicate, one above and one below, the horizontal tail surface, triangular in shape, hinged to, and forming movable prolongations of the vertical surface of the tail; it was changed again in the No. VII machine with which he made his second attempt and which was used at Rheims. In this model the rudder for horizontal direction was a single triangular vertical surface, while the rudders for steering up and down were double, one on each side, as in the No. V machine. M. Levavasseur

FIG. 2. LATHAM'S "ANTOINETTE" MONOPLANE IN WHICH HE MADE THE RECORD FLIGHT AT RHEIMS

states that he has found triangular rudders to be just as effective as rectangular rudders, and that they can be made lighter and stronger. These rudders and surfaces affecting the stability of the aëroplane are very effective on account of the great distance which they are placed behind the center of gravity, they are sensitive on account of the large leverage and they keep the machine in its path of flight as an arrow which has its weight in front and the feathers far in the rear.

### The Wing Tips and Methods of Obtaining Lateral Stability

Lateral stability in turning and in gusts of wind is secured by the "ailerons" or wing tips, which are small auxiliary plain surfaces hinged to the rear edge of the main wings, and at their outer extremity. When not in action they form merely continuations of the main surface. They are so connected by wires that when one is turned down the other is turned up, increasing the lifting effect on the side on which the wing tip is turned down and producing a depressing effect on the opposite side that is turned up, the combination acting as a couple which tends very strongly to right the machine. This arrangement acts in very nearly the same manner as warping the wing surfaces.

M. Levavasseur, finding the "ailerons" somewhat unsatisfactory and not delicate enough, constructed the "Antoinette" machine No. VII with warpable wings which Mr. Latham used in his second attempt to cross the channel as mentioned above and in his great flights for hight, distance and speed at Rheims.

In this machine the outer parts of each wing are able to be inclined in an opposite manner by means of the balancing wheel in the center of the machine, causing a very similar action to that of wing tips in restoring the equilibrium, but a little less energetic.

### The Control

The control of the direction and the balancing of the aëroplane are in the hands of the pilot. One wheel which can be turned forward and back, placed at the right-hand side, governs elevating and descending, being connected by wires to the rudders in the rear. See Fig. 5. Two other wheels placed at the left-hand side govern the wing tips or "ailerons" and the rudder for steering to the right or left. These two steering wheels may be operated together or individually by the same hand, one wheel is allowed to slip while the other completes the manœuvre. The system is very ingenious and essentially practical; it permits combination movements which make the handling of the apparatus very easy, as two simultaneous movements are necessary in turning and counteracting the action of gusts of wind.

Two small handwheels are in front of the operator to advance the spark and adjust the carbureter. A pedal is provided for cutting out the motor momentarily and a switch operated by hand is used to stop the motor entirely.

In the later machine used by Mr. Latham, the steering in the horizontal plane was done by a pivoted cross bar moved by his feet connected by wires to the vertical rudder.

In calm air the machine almost governs itself and in turbulent air it is very responsive to the slightest touch.

### The Chassis or Supporting Apparatus

The apparatus for supporting the machine on the ground consists of a skid, two light springing outriggers or supports for the wings, and a support for the tail. The skid running under the forward end of the aëroplane is fitted with a strong pneumatic bicycle wheel mounted in a fork at its rear end, almost under the center of gravity, and which therefore supports almost the entire weight of the machine; at the forward end of the skid and at the point where it would first touch the ground is a small roller to keep the front end from digging into the ground when landing. It will allow the machine to land at an angle of 45 degrees.

The skid raises the machine fully a meter (39 inches) from the ground and completely protects the propeller from striking when landing. The supports by which the skid is attached to the framework or the body are composed of two steel tubes which "telescope," one fitting into the other in such a manner that they act as a cylinder and piston compressing the air and absorbing the shock. The forward support has a play of 40 centimeters (1.3 inches), and the rear 60 centimeters (2 inches), and the air pressure can be regulated to absorb the entire force of the shock.

Light outriggers are placed under the center of each wing and prevent them from striking the ground; they serve also as spreaders for the guy wires which truss the wings and are provided with rollers at their lowest extremity. These props limit the transverse movement to an angle of less than 45 degrees; and in ordinary conditions of flight, the machine never tips to as great an angle as this.

The tail is supported by a light brace and shoe which steadies the machine in a longitudinal direction. On starting to leave the ground the apparatus attains a speed sufficient to maintain its equilibrium, the skid, outriggers, and the shoe supporting it, until the speed increases sufficiently to cause the air to take up the burden of the machine. Then, supported by its wings, with a few oscillations from side to side it goes faster and faster until it leaves the ground and becomes perfectly stable in the air.

The late machines were provided with two pneumatic wheels set some distance apart and attached to a single supporting pillar thoroughly braced by wires, thus doing away with the necessity of supports under the wings.

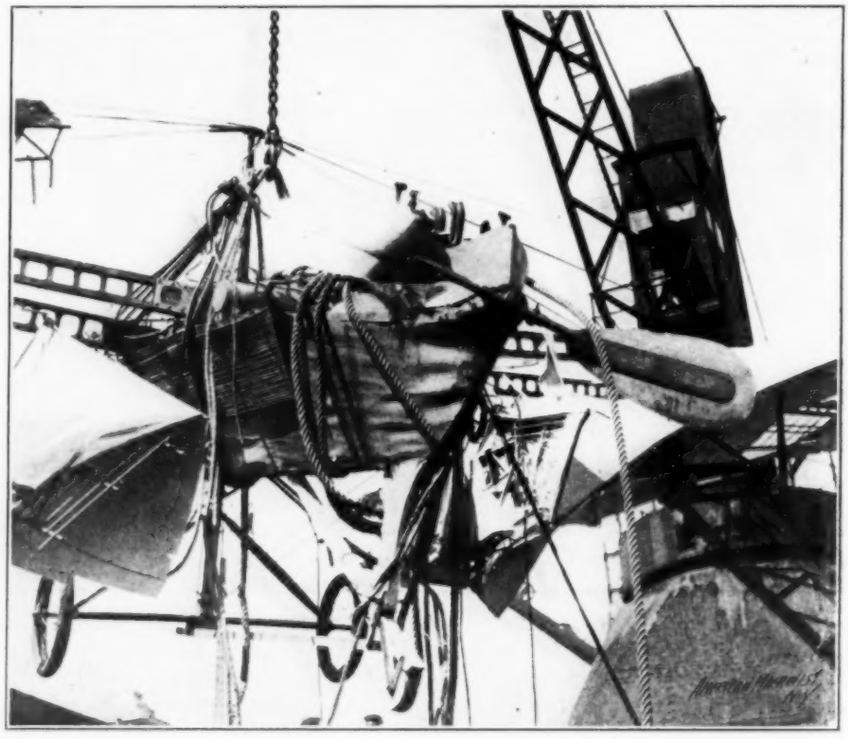


FIG. 3. LANDING LATHAM'S WRECKED "ANTOINETTE" MONOPLANE AFTER CHANNEL FLIGHT

### The Power Plant

The motor power consists of an

"Antoinette" motor, placed in the forward part of the body framework, easily dismountable, and a two-bladed metal propeller. See Fig. 6.

The motor is 55 horsepower; it has 8 cylinders placed at an angle like the letter V, the cylinder and cylinder head being made out of one solid block of soft iron; it is a veritable piece of sculpture both externally and internally and a particularly fine example of machine construction. Every pound of useless weight is taken off with the greatest skill. This type of motor has saved over their 1908 motor, as much as 700 grams (1.5 pounds) per cylinder or over 5 kilograms (11 pounds) for the 8 cylinders, making the weight of the motor about 75 kilograms (165 pounds). The water jacket is made seamless and all in one piece of pure copper deposited by electroylsis. This motor does not use a carbureter but injects the gasolene directly into each cylinder. The Wright brothers use a similar method of injecting gasolene by a pump with the exception that they inject the gasolene into one common connecting tube itself a form of surface carbureter.

The radiator or rather condenser used on the "Antoinette" consists of a number of long and small aluminum tubes placed along the outside of the body framework on each side of the cockpit.

The "Antoinette" engines are always run above the boiling point and the steam given off is condensed in these tubes and returned to the water jackets around the cylinders. This complete closed system has a thermo-siphon action but a pump is

FIG. 5. LATHAM IN HIS "ANTOINETTE" MONOPLANE, SHOWING THE OPERATING HAND WHEELS

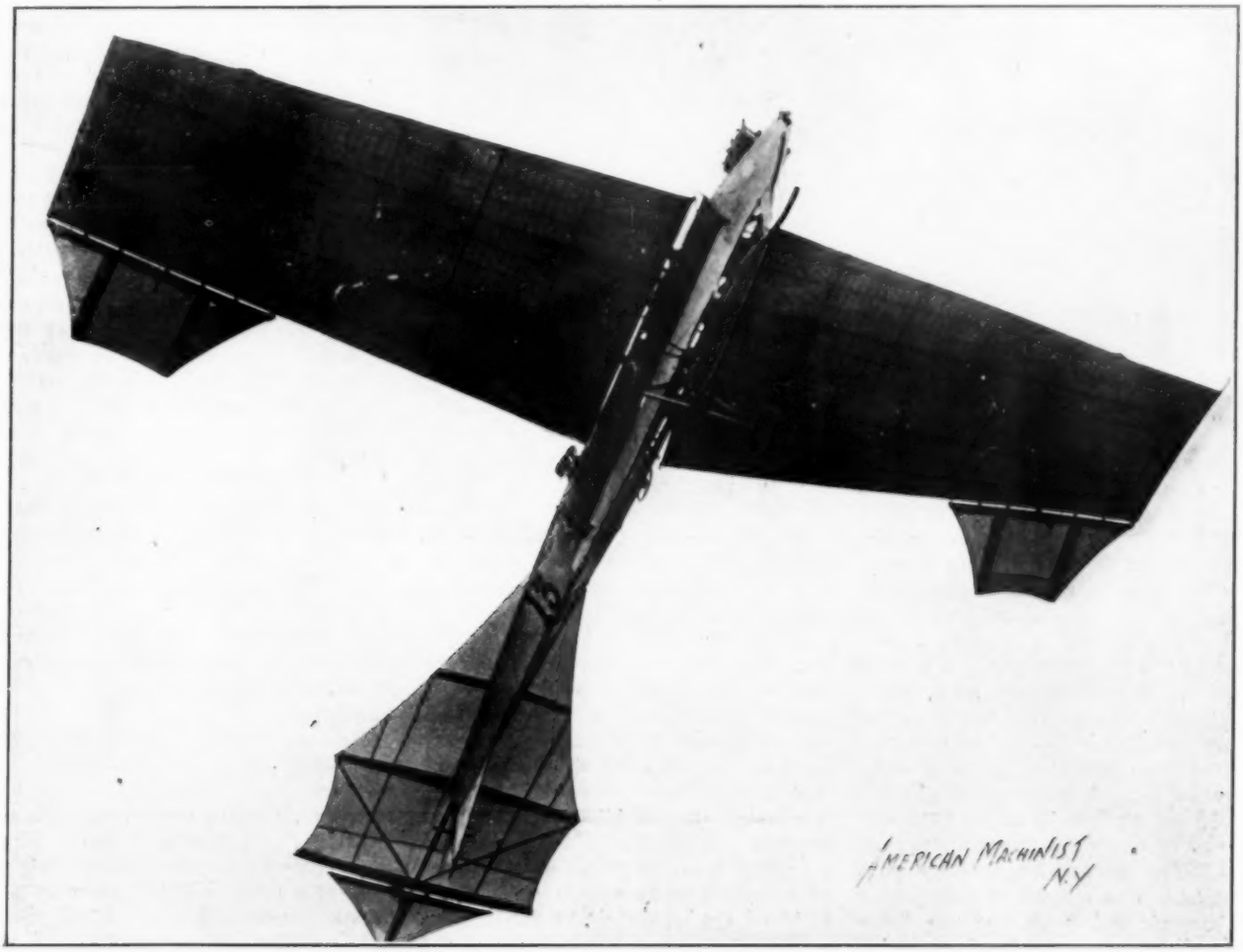



FIG. 4. UNDERNEATH VIEW OF "ANTOINETTE" MONOPLANE IN FLIGHT, NOTE SHAPE, RIBBING, ETC.

introduced to return the water to the cylinder jackets. The amount of water for cooling is 12 liters (3 gallons). The propeller has two blades of aluminum riveted to a steel tube directly connected to the motor without any intermediate gearing, thus saving weight. The diameter is 2 meters 20 centimeters (7.2 feet), the pitch 1 meter 30 centimeters (4.2 feet) and it makes 1100 revolutions per minute. The total supporting surface of the aëroplane is 50 square meters (538 square feet). It is 11 meters 50 centimeters (37.7 feet) long between perpendiculars, 12 meters 80 centimeters (42 feet) wide, and its total weight is 520 kilograms (1144 pounds).

The No. IV is somewhat smaller; it has 30 square meters (323 square feet) of supporting surface, it has a 50-horsepower motor which makes 1400 revolutions per minute and ready to fly 1 hour

FIG. 6. PROPELLER AND ENGINE OF AN "ANTOINETTE" MONOPLANE

weighs 460 kilograms (1012 pounds) without the operator.

The cock pit and aviator's seat is placed about 9 feet from the front end of the framework of the body, a safe distance from the propeller and in a commanding position in the center of the body of the machine; the aviator is comfortably provided with a cushioned seat and a metal protection in front against flying pieces in case of breakage. This is also padded to prevent injury if the operator is thrown forward by an abrupt landing. Mr. Latham has often worn a splinterproof suit and both he and M. Rene Demanest have been accustomed to strap themselves into their seats. The comparative fragility of a monoplane is an element of safety for it will crumple and break, and absorb the force of the impact. This aëroplane has made many world's records. A record for duration by a monoplane was made on June 5 at Camp de Chalons when Hubert Latham flew 1 hour, 7 minutes and 37 seconds.

Two attempts to cross the English channel were made by Latham in his "Antoinette" IV on July 19, 1909. After he had gone six miles the motor stopped at an altitude of about 1000 feet and he was forced to glide down to the surface of the water. Here he was picked up by the torpedo boat "Harpon," calmy smoking a cigarette while his aëroplane floated safely on the sea. He made another attempt on the 27th with his No. VII machine and got within a mile of Dover, when his motor stopped and again he was picked up in safety.

At Rheims Latham with his "Antoinette" monoplane No. 29, won second place in the Grand Prix de Champagne, offered for the greatest distance covered in a continuous flight, by flying 154 kilometers 500 meters in 2 hours, 18 minutes and 9 seconds and received 25,000 francs ($5000).

He also secured fifth place with his second machine and flew 111 kilometers in 1 hour, 38 minutes and 15 seconds and received 5000 francs ($1000).

In the "Prix de la Vitesse" he won second place in 25 minutes, 18 seconds receiving 5000 francs ($1000).

And in the "Tour de Piste" 10 kilometers he was third in 8 minutes 32 seconds. He was third also in the "Gordon Bennett" International Cup Contest, completing the 20 kilometers in 17.32 seconds.

Latham won the "Prix d L'Altitude" of 10,000 francs by a flight reaching the hight of 155 meters (508.5 feet). This was a most spectacular performance and he seemed like a small bird hovering in the air at this great elevation.

"Antoinette" machines can now be purchased in France for 25,000 francs each ($5000), to which duty, packing and shipping into the United States would add about 50 per cent. in all.

## Some Tests of Grease Lubrication

Under what conditions is grease a better lubricant than oil? This question is of practical interest to every user of machinery, yet it is probable that not more than 1 per cent. of machinery users could give a clear and correct answer. The usual assumption is that, owing to its greater viscosity, grease acts as a drag on the bearings and is, therefore, to be avoided if possible. Consequently oil is tried first, unless the machine is arranged for grease lubrication. If the bearings do not heat with oil the investigation ends there. If trouble is experienced, grease of one kind or another is tried, and by skill or good luck a *modus vivendi* is found.

The accompanying diagrams and tables are taken from a report of tests of various lubricants recently carried out at Cornell University by Professors Sawdon and Diederichs under the supervision of Prof. R. C. Carpenter. To many readers they will, no doubt, come as a surprise, owing to the rather remarkable ability shown in certain cases to endure bearing pressures of 400 pounds per square inch and upward. Incidentally, the tests are rather upsetting to the common theory that grease necessarily has a higher coefficient of friction than oil.

The tests mentioned were made for the Keystone Lubricating Company, and Keystone Grease was used in two of the eight tests. The full schedule of the tests is as follows: 1, heavy mineral grease; 2, a standard animal grease; 3, graphite grease; 4, mineral grease, softer than No. 1, and of another make; 5, engine oil (lubricating oil); 6, engine oil, another make; 7, Keystone Grease, No. 2 density; 8, Keystone Grease, No. 1 density.

### Object of the Tests

The primary object of the tests was to determine the ability to endure extreme bearing pressures. Nevertheless, they were begun at ordinary pressures (86 pounds per square inch), and the loads were increased by steps, so that valuable data were obtained regarding the history of the curves of coefficient of friction and temperature.

The apparatus used was an Olsen testing machine having a journal diameter of 3¾ inches, and length 3½ inches. In order to obtain the desired pressures per square inch the bearing area was somewhat reduced, and the bearing took the form of a babbitt-metal segment or shoe having a projected area of 5.8 square inches. This was subjected successively to total loads of 500, 1000, 1500, 2000, 2500 and 3000 pounds, provided the lubricant

showed itself able to carry such loads. If the bearing gave evidence of seizing the test was discontinued. Except in such cases each test was continued for one hour, the journal speed being approximately 240 revolutions per minute, or 236 feet per minute. Observations were taken at 10-minute intervals of the bearing temperature, temperature of the room, the speed and bearing friction. From the total friction were calculated the friction in pounds per square inch and the coefficient of friction.

The grease was fed in the same manner in all of the grease tests. An oil groove was cut near and paralleling the front edge of the bearing, and its ends were turned and carried across the ends of the bearing to the leaving edge. A hand compression cup supplied grease to the center of the bearing on the entering edge. This cup was given a one-eighth turn every half minute for low pressures, and more for added loads. The weight of the lubricant supplied to the bearing during each run was obtained, also the weight dropped from the bearing. In the two oil tests the journal ran in an oil bath.

The results of the tests as regards temperature and coefficient of friction are plotted graphically in Figs. 1 to 9 (inclusive). Special features of the several tests were as follows:

### Features of the Tests

1. Friction coefficient lowest at about 220 pounds per square inch. During the test there was a considerable tendency for the grease to work off the journal. Under a load of 345 pounds per square inch the grease was so fluid as to pass readily off the end of the journal, leaving almost none at the front edge of the bearing. An attempt to run under 431 pounds per square inch led to smoking after 20 minutes, and the test was discontinued.

2. Coefficient of friction higher than with mineral grease, owing to heat required to soften the animal fats. Under all but the lowest pressure the grease melted, ran off and dripped like oil. The run under 431 pounds pressure was continued to the end of the hour, but the grease turned black and the temperature was considerably above normal.

3. This test could not be extended to pressures higher than 172 pounds per square inch. The greasy component softened and ran like oil, while the graphite filled the oil groove till it had to be removed with a piece of metal. The coefficient of friction was higher than shown by the tests of other lubricants. This test appeared to show that graphite grease is properly used as "dope" for gears and under similar conditions where subjected to churning, but is not adapted to bearing lubrication.

4. This test showed a low coefficient of friction for loads between 150 pounds and 350 pounds per square inch. The bearing failed to carry a load of 431 pounds, as it filled immediately with a black, gritty substance preventing the entry of further grease, and was scored.

5. First oil test. A low coefficient was shown under moderate loads, but it rose very rapidly under higher loads. After running 30 minutes under 258 pounds the bearing smoked and it was found on stopping the test to be badly cut.

6. This oil showed a better test than 5, beginning with a lower coefficient of friction and enduring an hour's run under 258 pounds. It turned black, however, under the latter load.

7. Under loads from 150 to 300 pounds per square inch this grease (Keystone Grease, No. 2 density) showed a coefficient of friction lower than the best test of oil (6), and under loads up to about 360 pounds a smaller coefficient of friction than any of the other greases. The run under 431 pounds load came to an end after 58 minutes owing to the grease cup being empty and the bearing heating up in consequence. In that time 3.23 ounces of grease had been supplied. The grease showed signs of disintegration under heavy loads, but did not turn black until the grease ran out.

8. (Keystone Grease, No. 1 density.) A striking feature of this test was the continual downward slope of the curve of coefficient of friction, as compared with the saucer-shaped curves given by all other lubricants; 2⅞ ounces were fed to the bearing in the last hour's run. Under the high temperatures and pressures of the last two runs of the test the grease softened considerably, but not enough to cause it to be squeezed out, which would have increased the coefficient of friction. After running successfully for an hour under 3000 pounds total load—which had been done with no other grease—a total load of 3500 pounds (603 pounds per square inch) was applied, and the journal ran for nearly a minute before it suddenly gripped.

The makers attribute the exceptional performances of the two samples of Keystone Grease to the process of manufacture, which gives a practically pure petroleum product with none of the adulterants sometimes used to give body. The tenacity of the No. 1 density in the last test may perhaps be accounted for by the peculiar clinging quality of this grease, a feature on which its makers lay especial

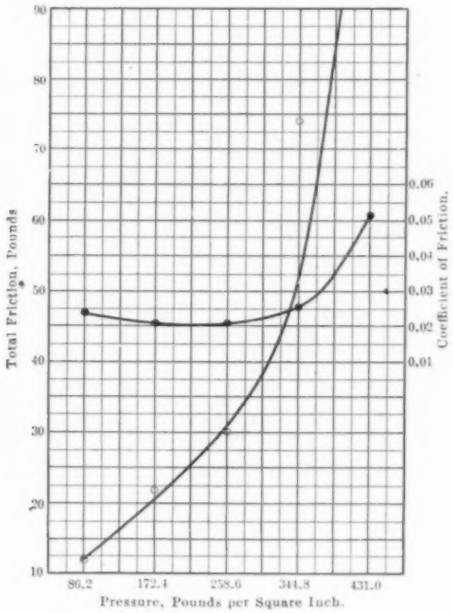



FIG. 1. CURVES FROM TEST 1 OF A HEAVY MINERAL GREASE

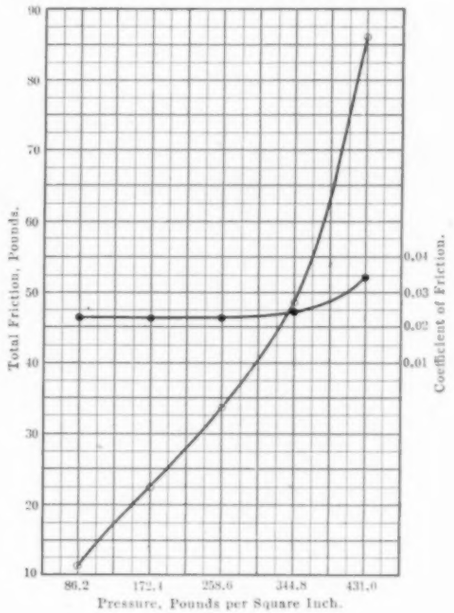



FIG. 2. CURVES FROM TEST 2 OF A STANDARD ANIMAL GREASE

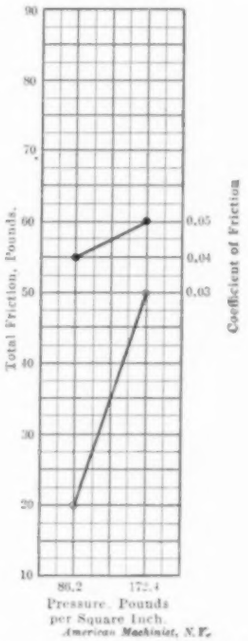



FIG. 3. CURVES FROM TEST 3 OF A GRAPHITE GREASE

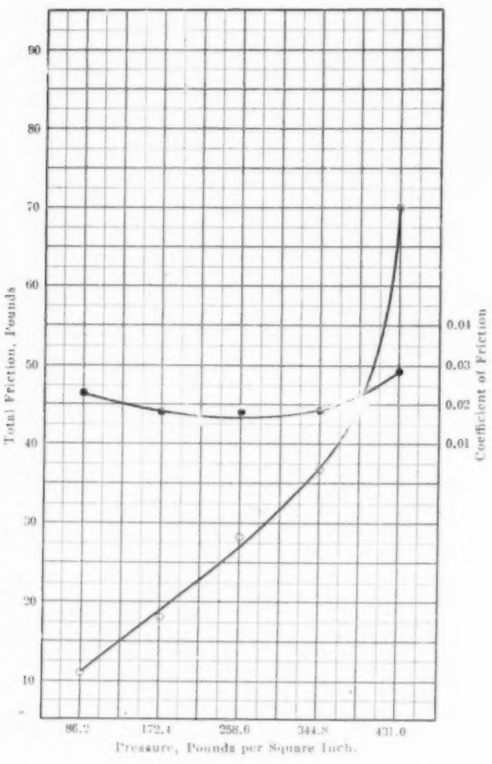



FIG. 4. CURVES OF TEST 4 OF A MINERAL GREASE SOFTER THAN NO. 1

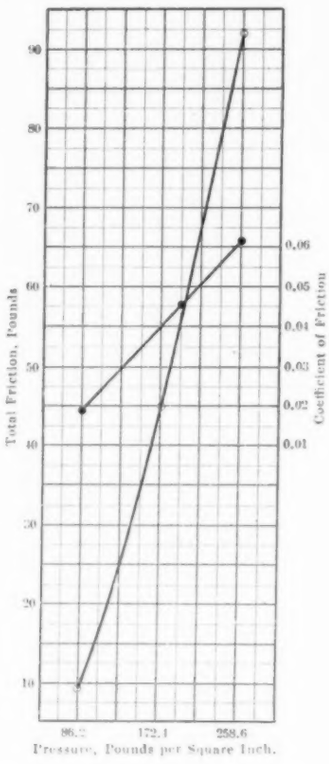



FIG. 5. CURVES OF TEST 5 OF AN ENGINE OIL

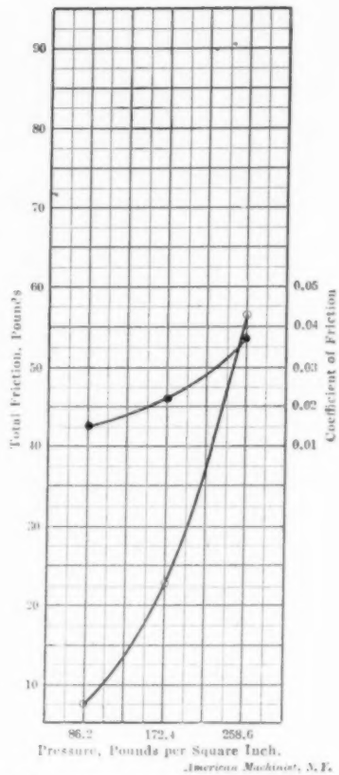



FIG. 6. CURVES OF TEST 6 OF ANOTHER ENGINE OIL

stress. They point out that it tends by its own nature to adhere to the journal and bearing, whereas a fluid lubricant like oil, or a grease which (like animal grease) liquefies in service and runs away like oil, cannot stay in the bearing until used up, but must be replaced by fresh lubricant as fast as it escapes. Owing to the natural tendency of the grease to stay in the bearing until forced out by the entry of fresh lubricant, especial economy is claimed for it.

Although it might not seem at first glance that tests such as the foregoing had much practical relation to ordinary machinery practice, nevertheless it is well to bear in mind that ordinary conditions sometimes become extraordinary at unforeseen moments. An instance of this was recently afforded by line shafting which had been running for several years in a large reducing room with oil lubrication. An additional load was put on the beams supporting the stock-room floor overhead. The slight deflection of the beams threw the shafting boxes out of line, and increased the pressure, which not only resulted in ruining the bearings by cutting, but caused the armature of the driving motor to burn out. Any mill man can recall instances where journals which have done their work regularly for months suddenly heat and seize, owing to the added load being put on them, or to some loss of alinement in the bearings.

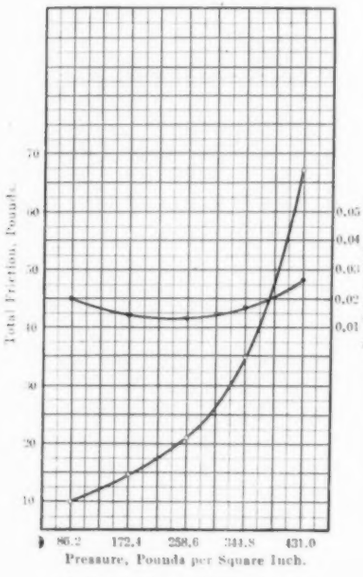



FIG. 7. CURVES OF TEST 7 OF KEYSTONE GREASE NO. 2 DENSITY

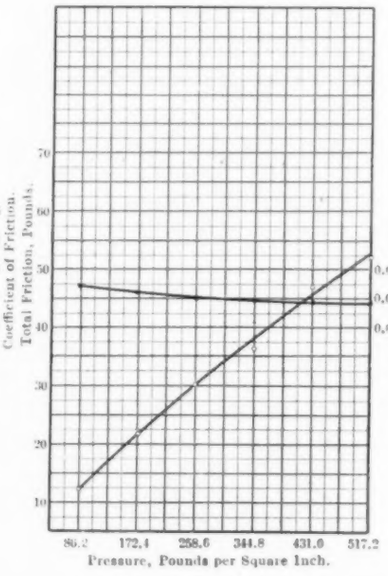



FIG. 8. CURVES OF TEST 8 OF KEYSTONE GREASE NO. 1 DENSITY

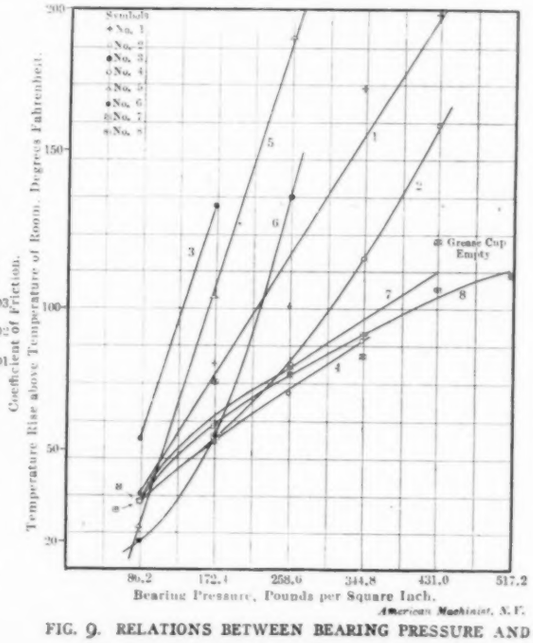



FIG. 9. RELATIONS BETWEEN BEARING PRESSURE AND RISE OF TEMPERATURE FOR THE EIGHT LUBRICANTS OF FIGS. 1 TO 8 INCLUSIVE

# An Investigation of Strength of Crane Hooks

## Results Obtained by a Theoretical Study are Closely Checked by Tests of Seven Hooks Ranging from 2 to 30 Tons Capacity

BY WALTER RAUTENSTRAUCH*

Some time ago the editor of the AMERICAN MACHINIST kindly offered to secure the coöperation of the manufacturers of crane hooks in the carrying on of a series of experiments to determine the correct principles underlying their design. Hooks, varying from 2 to 30 tons rated capacities, were furnished by five builders, and the experiments were performed in the materials testing laboratory at Columbia University. The firms which thus kindly aided in this work are: Niles-Bement-Pond Company, Shaw Electric Crane Company, Yale & Towne Company, Pawling & Harnischfeger, Curtis & Co. Manufacturing Company. As far as I have been able to learn, builders of crane hooks generally base their designs on the assumption that the maximum stress in the inner side of the main section of the hook is the result of the direct load on the hook, considered uniformly distributed over the section, and the stress due to the eccentricity of the load determined by the familiar bending-moment formula. This analysis is borrowed from the theory of flexure of straight beams, which requires for its application the following assumptions, among others:

1. That the gravity axis contains the neutral axis.

2. That the strain at any point in the section is directly proportional to the distance of that point from the neutral axis.

That these conditions do not obtain in the case of a curved beam under flexure, can be very easily demonstarted by attempting to apply Hooke's Law and Bernoullis' assumption to this particular case.

It seems, therefore, that the stress at any point of a section of a curved beam under flexure does not follow the same laws as that of a straight beam and is to some extent dependent on the radius to which the beam is originally curved at that section.

A number of attempts have been made in times past to formulate a relation between the load on a hook and the resulting maximum stress as a function of the radius of curvature at the most strained section, but there seems to be only one which is in any way verified by the results of experiments. In 1904 E. S. Andrews, of University College, London, with the assistance of Prof. Karl Pearson, of the same institution, published a new theory of stresses in crane hooks, with the results of a number of experiments which seem to establish that the new theory quite accurately represents the facts in the case. It will be my purpose, therefore, to call the attention of American manufacturers of crane hooks to this new theory and the results of some experiments performed on commercial hooks which show that a close relation exists between the theory and actual conditions.

*Professor of mechanical engineering, Columbia University.

### Development of Theory of Stresses in Crane Hooks

In presenting the theory the following notation will be used (see Fig. 1). Here

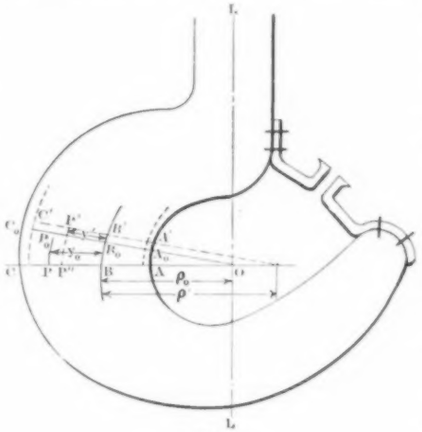


FIG. 1

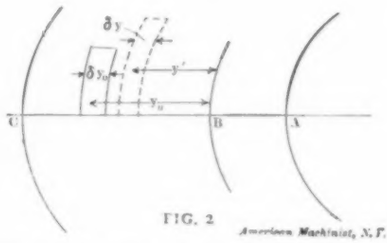


FIG. 2

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DIAGRAMS OF CRANE HOOK AND NOTATION

$A\,B\,C$ represents the principal cross-section taken normal to the load line $L\,O\,L$ and passing through the center of curvature $O$. In all of the hooks tested the center of curvature was on the load line. At $B$ is the gravity axis of the section $A\,B\,C$; $\rho_o$ is the distance that $B$ is from $O$. Section $A_o\ B_o\ C_o$ is a section made by passing a plane slightly above the plane $A\,B\,C$ and through $O$. The length of any "fiber" (using this term conventionally) between the two planes will be noted as $A\,A_o$, $B\,B_o$, $P\,P_o$, etc. By $Y_o$ is represented the distance of any "fiber," such as $P\,P_o$, from the gravity axis $B$ before any strain, due to loading, occurs. Values of $Y_o$ between $B$ and $C$ will be positive (+), and between $B$ and $A$ will be negative (—). Points $P''\ P'$ will represent the position taken by any fiber $P\,P_o$ after strain due to load occurs. It will be noted that the fiber under strain is at the distance $Y'$ from the gravity axis. The basis for this is the assumption that when strain occurs the plane $A_o\ B_o\ C_o$ moves parallel to itself and assumes a position $A'\,B'\,C'$ such that it intersects the plane $A\,B\,C$ at $O'$ and changing the radius of curvature $\rho_o$ of the "fibre" $B\,B_o$ to $\rho'$, the fibre $B\,B_o$ increasing in length to $B\,B'$. The elongation of all the "fibers" is coincident with a contraction of the section and a consequent moving in of all the "fibers" toward the gravity axis.

Let $E$ represent the modulus of elasticity in tension for the material used; $f_y$ the unit tension in any "fiber" a distance $y'$ from the gravity axis, and $\lambda_y$ represents the unit stretch or elongation to which this "fiber" is subjected when under tension $f_y$.

Accordingly, therefore, any "fiber" when under strain and a distance $y$ from the gravity axis may have the amount of unit tension to which it is subjected, represented by the equation

$$f_y = E\lambda_y \qquad (1)$$

It being established by definition that the modulus of elasticity $E$ shall be known as the ratio of the unit tension to the unit elongation, or $\frac{f_y}{\lambda_y}$.

The unit elongation $\lambda_y$ may be seen from Fig. 1 to be

$$\lambda_y = \frac{P'P'' - P_oP}{P_oP},$$

whence

$$P'P'' = P_oP\,(1 + \lambda_y) \qquad (2)$$

The geometry of Fig. 1 also shows that

$$\frac{P'P''}{BB'} = \frac{\rho' + y'}{\rho'} \qquad (3)$$

and

$$\frac{PP_o}{BB_o} = \frac{\rho_o + y_o}{\rho_o} \qquad (4)$$

The unit elongation of the fiber $B\,B_o$ when under strain will be represented by $\lambda_B$, whence

$$BB' = BB_o\,(1 + \lambda_B) \qquad (5)$$

Dividing equation (2) by equation (5),

and substituting from equations (3) and (4), the following relation is obtained:

$$\left(1 + \frac{y'}{\rho'}\right)\left(1 + \lambda_B\right) = \left(1 + \frac{y_o}{\rho_o}\right)\left(1 + \lambda_y\right),$$

from which it is found that

$$\lambda_y = \lambda_B + \frac{\frac{y'}{\rho'} - \frac{y_o}{\rho_o}}{1 + \frac{y_o}{\rho_o}}, \qquad (6)$$

which may be expressed:

$$\left(\lambda_y - \lambda_B\right)\left(1 + \frac{y_o}{\rho_o}\right) = \frac{y'}{\rho'} - \frac{y_o}{\rho_o} \qquad (7)$$

The distance $y'$ is variable, and consequently $\lambda_y$ is variable. So also is $y_o$ a variable, while $\lambda_B$ for any constant load is a constant. It becomes necessary in this analysis in order that a proper relation between all the variables may be established to determine the rate at which these several variables change value. This permits the introduction of certain values by substitution, necessary to the establishment of the relation between load, "fiber" stress and the proportions of the hook.

Using the familiar methods of the calculus, the rate at which the unit elongation varies with the position of the "fiber" is established as follows:

$$\delta\lambda_y\left(1 + \frac{y_o}{\rho_o}\right) + \left(\lambda_y - \lambda_B\right)\frac{\delta y_o}{\rho_o} = \frac{\delta y'}{\rho'} - \frac{\delta y_o}{\rho_o} \qquad (8)$$

The terms $\delta y_o$ and $\delta y$ each represent the width of a longitudinal strip of the material when it is a distance $y_o$ and distance $y'$ from the gravity axis. This is shown graphically in Fig. 2.

to Hooke's law, stress and strain (elongation) are proportional to each other up to the elastic limit. The unit lateral contraction of the strip in terms of the unit elongation $\lambda y$ may be expressed $\frac{1}{4}\ \lambda y$ or more generally $n\lambda y$.

Accordingly, therefore, it may be written

$$\frac{\delta y_o - \delta y}{\delta y_o} = n\lambda y,$$

from which

$$\delta y = \delta y_o\,(1 - n\lambda y).$$

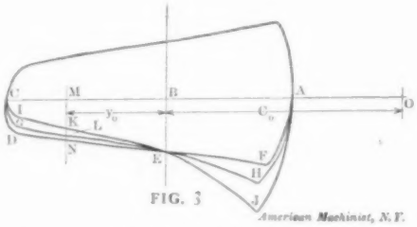


FIG. 3

PRINCIPAL CROSS-SECTION AND RIGIDITY CURVES OF A CRANE HOOK

This value of $\delta y$ may now be substituted in equation (8), which then reads

$$\frac{\delta\lambda y}{\frac{1}{\rho'} - \frac{1}{\rho_o} + \frac{\lambda_B}{\rho_o} - \lambda y\left(\frac{1}{\rho_o} + \frac{n}{\rho'}\right)} = \frac{\delta y_o}{1 + \frac{y_o}{\rho_o}}.$$

If for

$$\lambda_y\left(\frac{1}{\rho_o} + \frac{n}{\rho'}\right)$$

there be written the close approximate

$$\lambda_y\left(\frac{1 + n}{\rho_o}\right)$$

known values for the variables $\lambda_y$ and $y_o$. That is, when $\lambda_y = \lambda_B$, then $y_o = O$. Whereupon

$$C = \frac{1}{\rho'} - \frac{1}{\rho_o} - \frac{n\lambda_B}{\rho_o}.$$

Substituting this value of $C$ in the above equation it is found that

$$\lambda_y = \lambda_B + \left\{\frac{\rho_o}{1 + n}\left(\frac{1}{\rho'} - \frac{1}{\rho_o}\right) - \frac{n\lambda_B}{1 + n}\right\}\left(1 - \frac{1}{\left(1 + \frac{y_o}{\rho_o}\right)^{1 + n}}\right), \qquad (10)$$

which gives as the unit stress on any "fiber" a distance $y'$ from the gravity axis;

$$y = E\lambda_B + E\left\{\frac{\rho_o}{1 + n}\left(\frac{1}{\rho'} - \frac{1}{\rho_o}\right) - \frac{n\lambda_B}{1 + n}\right\}\left(1 - \frac{1}{\left(1 + \frac{y_o}{\rho_o}\right)^{1 + n}}\right) \qquad (11)$$

Let

$W$ = The load on the hook,

$a$ = The unit area subjected to any intensity of stress $f_y$,

$A$ = The total area of section $= \Sigma a$.

Then

$$W = \Sigma\,(f_y a)$$

and

$$W\rho_o = -\Sigma\,(f_y a + y_o).$$

For the sake of brevity, the quantity

$$\left\{\frac{\rho_o}{1 \times n}\left(\frac{1}{\rho'} - \frac{1}{\rho_o}\right) - \frac{n\lambda_B}{1 + n}\right\}$$

may be written $Q$;

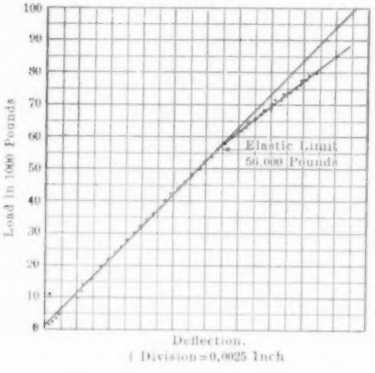


FIG. 5. 30-TON STEEL HOOK

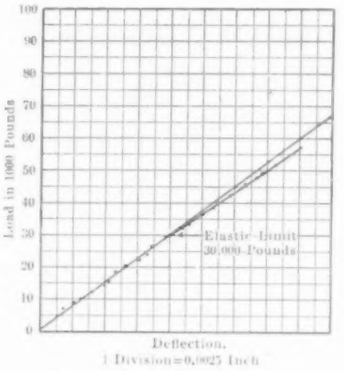


FIG. 7. 20-TON STEEL HOOK

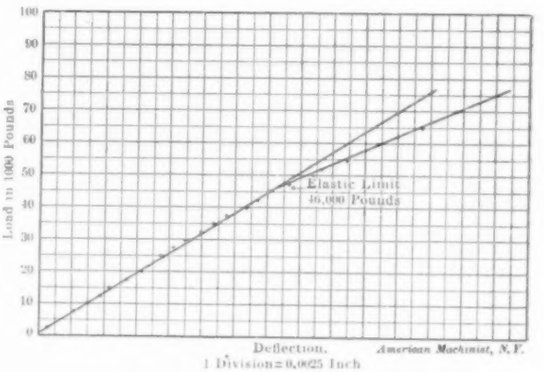


FIG. 9. 15-TON CAST-STEEL HOOK

STESS-STRAIN DIAGRAMS OF STEEL CRANE HOOKS

The strip of material of width $\delta y_o$ in moving toward $B$, as previously explained, has contracted to the width $\delta y$. There has been a change in width $= \delta y_o - \delta y$, or a unit change

$$\frac{\delta y_o - \delta y}{\delta y_o}.$$

Numerous experiments with materials have demonstrated the fact that this transverse shortening or contraction amounts to about one-quarter the elongation of the strip. This relation was first observed by Poisson, and is known as Poisson's ratio, and generally written $(n)$. According

and the equation integrated, there is found

$$-\frac{\rho_o}{1 + n}\,log.\left[\frac{1}{\rho'} - \frac{1}{\rho_o} + \frac{\lambda_B}{\rho_o} - \lambda_y\left(\frac{1 + n}{\rho_o}\right)\right] = \rho_o\,log.\left(1 + \frac{y_o}{\rho_o}\right) + log.\,C,$$

which reduces to

$$\frac{1}{\rho'} - \frac{1}{\rho_o} + \frac{\lambda_B}{\rho_o} - \lambda_y\left(\frac{1 + n}{\rho_o}\right) = \frac{C}{\left(1 + \frac{y_o}{\rho_o}\right)^{1 - n}}. \qquad (9)$$

The value of the constant of integration is determined by substituting coincident

and for the quantity

$$\Sigma\left(\frac{a}{\left(1 + \frac{y_o}{\rho_o}\right)^{1 + n}}\right)$$

write $A\,y_1$, and for

$$-\Sigma\left\{\frac{a\,\frac{y_o}{\rho_o}}{\left(1 + \frac{y_o}{\rho_o}\right)^{1 + n}}\right\}$$ written $A\,y_2$.

It will be found that

$$W = EA\lambda_B + EQA\,(1 - y_1),$$

and

$$-W\rho_o = EAQ\rho_o\,y_2.$$

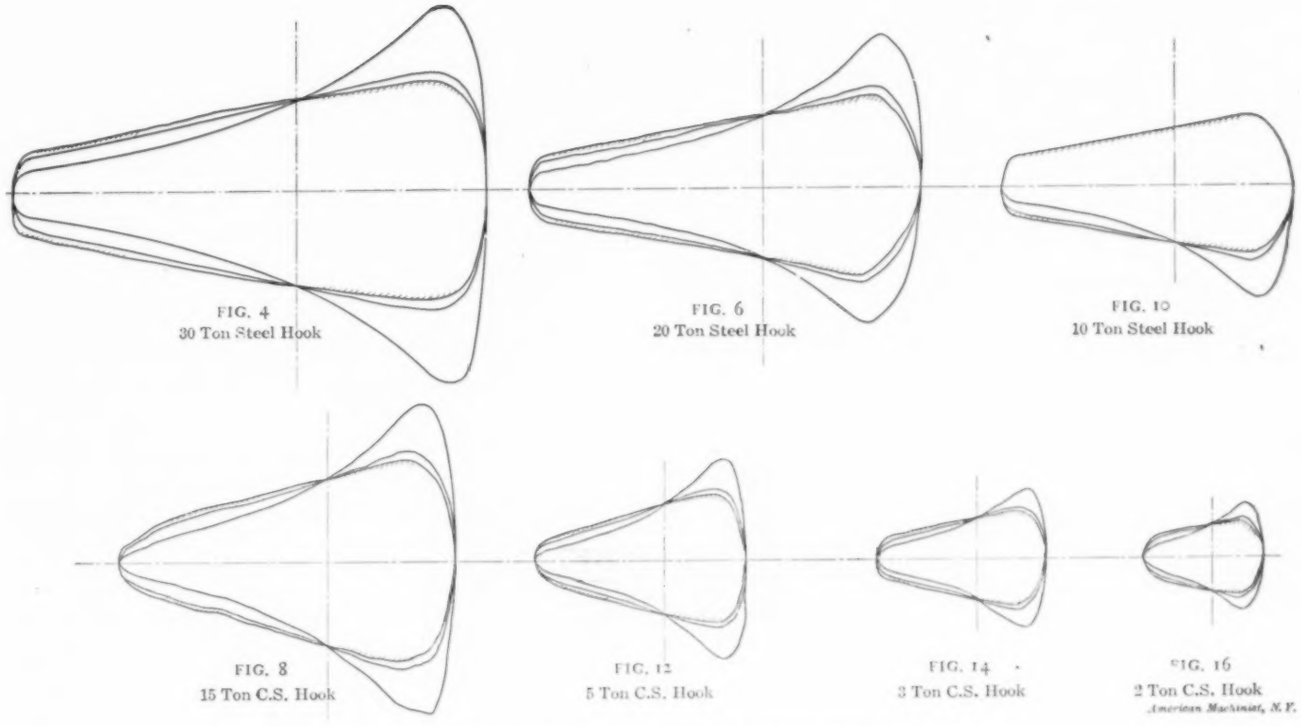

FIG. 4
30 Ton Steel Hook

FIG. 6
20 Ton Steel Hook

FIG. 10
10 Ton Steel Hook

FIG. 8
15 Ton C.S. Hook

FIG. 12
5 Ton C.S. Hook

FIG. 14
3 Ton C.S. Hook

FIG. 16
2 Ton C.S. Hook

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PRINCIPAL CROSS-SECTION AND RIGIDITY CURVES OF SEVEN STEEL CRANE HOOKS

It will appear then that

$$Q = -\frac{W}{EA\gamma_2},$$

and

$$\lambda_B = \frac{W}{EA} + \frac{W}{EA}\left(\frac{1-\gamma_1}{\gamma_2}\right). \quad (12)$$

Equating the two values of $Q$ just determined, it is found that

$$\frac{1}{\rho} - \frac{1}{\rho_o} = \frac{W}{EA}\left\{-\frac{(1+n\gamma_1)}{\gamma_2\rho_o} + \frac{n}{\rho_o}\right\}. \quad (13)$$

Substituting the values found in equations (12) and (13) in equation (11) it is found that

$$f_y = \frac{W}{A}\left\{1 + \frac{1}{\gamma_2}\left(\frac{1}{\left(1-\frac{y_o}{\rho_o}\right)^{1+n}} - \gamma_1\right)\right\}. \quad (14)$$

Which equation represents the intensity of stress at any point in the section a distance $y^o$ from the gravity axis. Accordingly, therefore, if $y_o$ be given a value $-dt$, the distance of maximum intensity of tensile stress from the gravity axis, the result will be $f_t$, the maximum intensity of tensile stress in the section, or

$$f = \frac{W}{A}\left\{\gamma_2\left(\frac{1}{\left(1-\frac{dt}{\rho_o}\right)^{1+n}} - \gamma_1\right) + 1\right\}. \quad (15)$$

Likewise if $y_o$ be given a value $+ d_c$ the distance of the maximum intensity of compressive stress from the gravity axis, the result will be $f_c$, the maximum intensity of compressive stress in the section, or

$$f_c = \frac{W}{A}\left\{\frac{1}{\gamma_2}\left(\gamma_1 - \frac{1}{\left(1+\frac{d_c}{\rho_o}\right)^{1+n}}\right) + 1\right\}. \quad (16)$$

The solution of these equations requires known values of $\gamma_2$ and $\gamma_1$.

Referring to the equations preceding equation (12) it is seen that

$$\gamma_1 = \frac{\Sigma\left(\frac{a}{\left(1+\frac{y_o}{\rho_o}\right)^{1+n}}\right)}{A} = \frac{\Sigma\left(\frac{a}{\left(1+\frac{y_o}{\rho_o}\right)^{\frac{5}{4}}}\right)}{A}$$

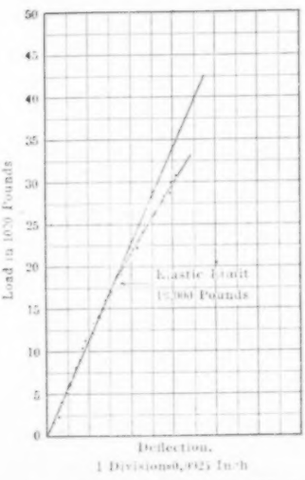


FIG. 11. 10-TON STEEL HOOK

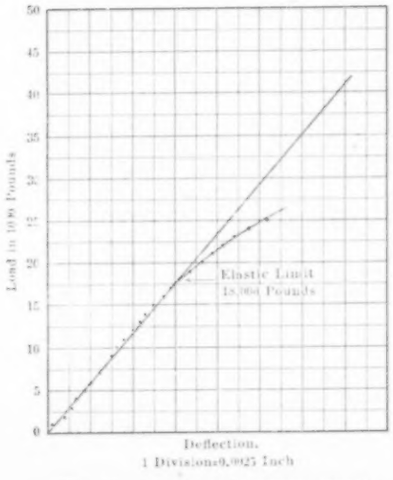


FIG. 13. 5-TON CAST-STEEL HOOK

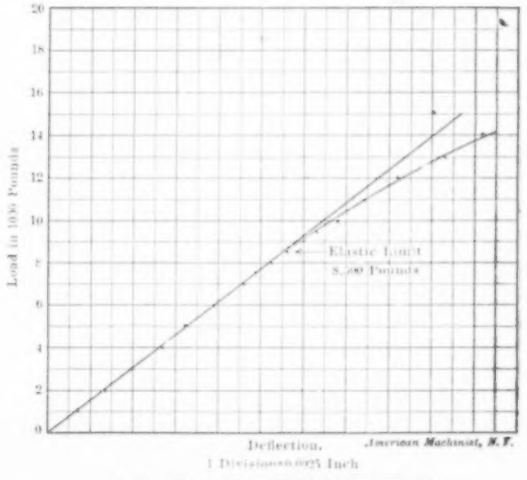


FIG. 15. 3-TON CAST-STEEL HOOK

STRESS-STRAIN DIAGRAMS OF STEEL CRANE HOOKS

and

$$y_2 = \frac{-\Sigma\left(\frac{a\,\frac{y_o}{\rho_o}}{\left(1+\frac{y_o}{\rho_o}\right)^{\frac{1}{2}}}\right)}{A} = \frac{-\Sigma\left(\frac{a}{\left(1+\frac{y_o}{\rho_o}\right)^{\frac{1}{2}}}\right)}{A} + y_1$$

### Graphical Determination of Functions from Hook Section

Graphically these functions are determined as follows, See Fig. 3:

Let the half of the hook section be represented by $A\,B\,C\,D\,E\,F$. At any point $M$ a distance $y_o$ from the gravity axis through $B$, the half ordinate of the hook section is $M\,N$. Determine a point $L$ on the curve $C\,G\,E\,H\,A$, which shall be a distance from $M$ equal to

$$\frac{M\,N}{\left(1+\frac{y_o}{\rho_o}\right)^{\frac{1}{2}}}.$$

It can easily be seen that the area under the curve $C\,G\,E\,H\,A$ divided by the half area of the section will equal the function $y_1$.

If also a series of points as $K$ be determined, such that

$$M\,K = \frac{M\,N}{\left(1+\frac{y_o}{\rho_o}\right)^{\frac{1}{4}}},$$

a curve similar to $C\,I\,K\,E\,J\,A$ will be determined, the area under which minus the area $C\,Q\,E\,H\,A$ when divided by the half area of the section will represent the function $y_2$.

The functions $y_1$ and $y_2$ are, therefore, to be determined as above for each hook to be tested. A very beautiful geometric construction for the determination of these curves is had in Mr. Andrews' original paper, but I have found the above method shorter and more convenient.

It will be observed, then, that equation (15) furnishes a relation by which it is possible to predict the maximum intensity of tensile stress that will occur in any hook of known form when subjected to a known load $W$. The limit of application, however, is the elastic limit of the material, and it will not be possible to determine the intensity of stress at which a hook will break if loaded up to the breaking point, or *vice versa*. If this theory is correct, the elastic limit of any material measured by a direct-tension test should coincide with the elastic limit of the same material when made in the form of a hook and tested by measuring the rate of change of the opening with the load.

### Method of Conducting Experiments

The experiments were conducted as follows: Each hook was provided with a pair of hardened-steel points, as shown in Fig. 1 for the purpose of measuring the openings. This was accomplished by the use of a micrometer caliper, reading to $\frac{1}{10{,}000}$ inch. The principal cross-section of the hook was marked off and a cast of it made with molders' wax and plaster of paris. When the cast was hard it was cut down to the line $A\,B$ (the principal section) and then removed. The parts were laid on paper and the sections marked off. The principal dimensions of the section were previously calipered to serve as a check on the draft made from the casts. From this draft of the section the area was obtained and also the curves for determining the functions $y_1$ and $y_2$. The radius of curvature of the belly was measured by scribing the forms of the belly on drawing paper and by a compass, determining the curvature at the principal section $A$. The hook was provided with top and bottom clevises for fastening in the testing machine. The bottom clevis was provided with a rough knife edge to fit in a V-groove in the bottom of the hook and on the load line. The larger hooks were tested by the use of an Olsen 400,000 -pound machine, while the smaller hooks were tested on Rhiele machines of 100,000 pounds and 60,000 pounds capacities. Because of the fact that when the elastic limit in the hook is reached it occurs only at one point, it is difficult to accurately locate it. Not until the material over a considerable portion of the hook section has been stressed beyond the elastic limit does a noticeable deviation in the elastic curve occur. It will be seen that considerable more difficulty attends the determination of the elastic limit in hooks than in tensions test bars. The tests of ten hooks, ranging from 30 to 2 tons capacities are reported below, together with the determination of the elastic limit of the material by the use of a test specimen, and by computations with the use of the new formula and the old formula.

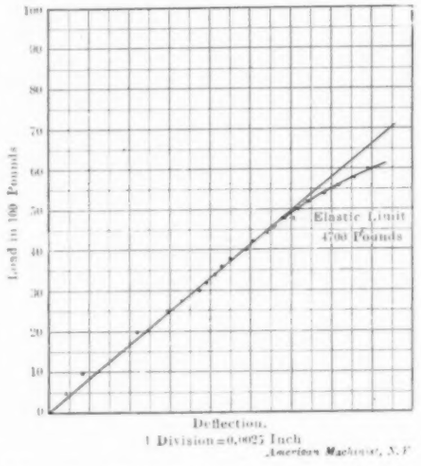


FIG. 17. STRESS-STRAIN DIAGRAM OF A 2-TON CAST-STEEL CRANE HOOK

### Thirty-ton Steel Hook

The form of the principal cross-section and the hook rigidity curves are shown in Fig. 4. Fig. 5 gives the results of the experiment. Area of section = 23.35 square inches. $y_1 = 1.089$, $\rho_o = 7.25$ inches, $y_2 = 0.08$, $d_l = 3.36$ inches, $W = 56{,}000$ pounds, $I = 111.6$. Substituting these values in equation (15) $f_t = 34{,}600$ pounds. The elastic limit of the test specimen cut from the unstrained portion of the hook was 34,000 pounds.

The value of $f_t$ by the old formula =

$$\frac{W}{A} + \frac{W\,l\,d}{I} = 11{,}700$$

pounds, where

$W$ = Load at elastic limit,

$l$ = Distance from load line to gravity axis, and

$I$ = Moment of inertia of section about the gravity axis and the other

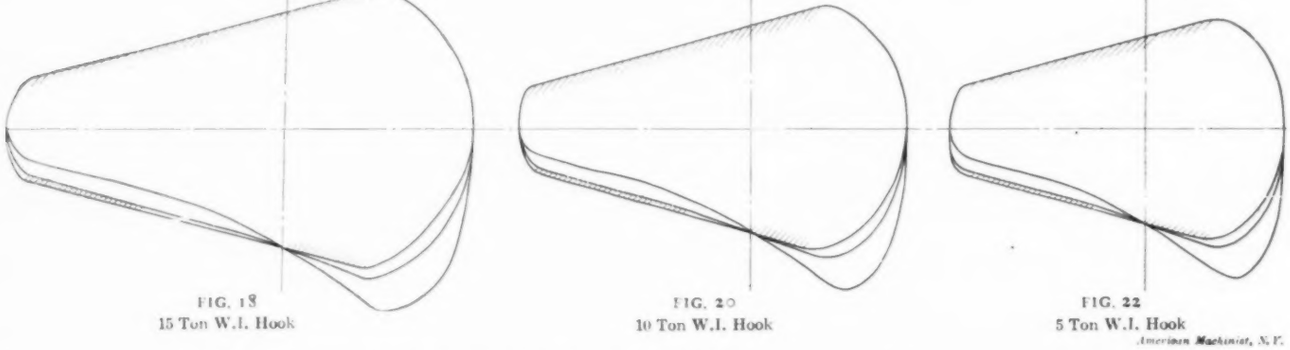

FIG. 18
15 Ton W.I. Hook

FIG. 20
10 Ton W.I. Hook

FIG. 22
5 Ton W.I. Hook
American Machinist, N.Y.

PRINCIPAL CROSS-SECTIONS AND RIGIDITY CURVES FOR THREE WROUGHT-IRON CRANE HOOKS

symbols are as in the new formula.

### Twenty-ton Steel Hook

Fig. 6 gives the principal cross-section and the hook rigidity curves, while the results of the hook test are given in Fig. 7.

Area of section = 14.48 square inches, $y_1 = 1.108$, $y_2 = 0.0967$, $W = 30{,}000$ pounds: $\rho_0 = 5.9$ inches, $d_t = 2.75$ inches.
Value of
$f_t$ by the new formula = 29,450;
$f_t$ by test of specimen = 28,500;
$f_t$ by old formula = 10,100 pounds.

### Fifteen-ton Cast-steel Hook

The section of this hook is shown in Fig. 8. The results of the test are shown in Fig. 9.

Area of section = 13.92 square inches, $y_1 = 1.058$, $y_2 = 0.0603$, $W = 48{,}000$ pounds, $\rho_0 = 5.13$ inches, $d_t = 2.23$ inches.
Value of
$f_t$ from new formula = 60,000;
$f_t$ from specimen = 62,750;
$f_t$ from old formula = 17,500 pounds.

### Ten-ton Steel Hook

Fig. 10 gives the section of the hook as well as the hook rigidity curves, and Fig. 11 gives the results of the hook test.

Area of section = 8.72 square inches, $y_1 = 1.095$, $y_2 = 0.849$, $\rho_0 = 4.3$ inches, $d_t = 2.05$ inches, $W = 18{,}000$ pounds.
Value of
$f_t$ from new formula = 28,000;
$f_t$ from specimen = 27,500;
$f_t$ from old formula = 11,600 pounds.

### Five-ton Cast-steel Hook

Figs. 12 and 13, respectively, show the main section of the hook and the results of the hook test.

Area of section = 5.69 square inches, $W = 18{,}000$ pounds, $y_1 = 1.072$, $y_2 = 0.065$, $\rho_0 = 3.25$ inches, $d_t = 1.42$ inches.
Value of
$f_t$ from new formula = 51,000;
$f_t$ from specimen test = 53,500;
$f_t$ from old formula = 17,000 pounds.

The specimen had a slight imperfection and the material of the hook was not very uniform so that a close agreement is not to be expected.

### Three-ton Cast-steel Hook

Figs. 14 and 15 give the principal section and the results of the test.

Area of section = 3.50 square inches, $W = 8500$ pounds, $y_1 = 1.04857$, $y_2 = 0.05428$, $\rho_0 = 2.89$ inches, $d_t = 1.16$ inches.
Value of
$f_t$ from new formula = 40,500;
$f_t$ from specimen test = 40,800;
$f_t$ from old formula = 22,400 pounds.

### Two-ton Cast-steel Hook

Fig. 16 contains the draft of the principal section and the hook rigidity curves. Fig. 17 gives the results of the hook test.

Area of section = 2.03 square inches, $W = 4700$ pounds, $y_1 = 1.0443$, $y_2 = 0.0492$, $\rho_0 = 2.03$ inches, $d_t = 0.88$ inches.
Value of
$f_t$ from new formula = 48,900;
$f_t$ from specimen test = 45,900;
$f_t$ from old formula = 16,200 pounds.

It is to be noted from this series of tests that prediction of the elastic limit of the material by the new formula is vastly more accurate than that given by the old formula, or, as the formula would be used in design, the load at the elastic limit can be quite accurately predicted by the new formula. Clearly, neither this formula nor the old formula can be used to determine the *breaking load* of the hook, since the very foundation of its derivation limits its application to the elastic limit of the material. Furthermore, this formula is applicable to the design of such machine members as punch frames, riveter frames and the general C-frame type of construction, experiments on which I hope to have under way in the near future.

I am indebted to Prof. Ira H. Woolson for the use of the testing laboratory, and T. C. Wood, George Crawley and Charles Marcus, former students in the department of mechanical engineering, for their assistance in the experiments.

### Results of Tests on Three Wrought-iron Hooks

Since the preceding material was prepared three wrought-iron crane hooks have been tested and the results are herewith presented; the accompanying illustrations are Figs. 18 to 23, inclusive.

### Fifteen-ton Wrought-iron Hook

The principal section and the hook rigidity curves are shown in Fig. 18, and the results of the experiment are shown in Fig. 19.

Area of section = 8.4 square inches, $I = 11.9$, $y_1 = 1.047$, $y_2 = 0.0476$, $\rho_0 = 5.0$ inches, $d_t = 1.87$ inches, $W = 16{,}000$ pounds.
Value of
$f_t$ from new formula = 31,600;
$f_t$ from test of specimen = 30,000;
$f_t$ from old formula = 14,500 pounds.

### Ten-ton Wrought-iron Hook

See Figs. 20 and 21.

Area of section = 6.08 square inches, $I = 6.5$, $y_1 = 1.066$, $y_2 = 0.0658$, $\rho_0 = 4.0$ inches, $d_t = 1.5$ inches, $W = 16{,}000$ pounds.
Value of
$f_t$ from new formula = 31,200;
$f_t$ from test of specimen = 30,000;
$f_t$ from old formula = 17,600 pounds.

### Five-ton Wrought-iron Hook

See Figs. 22 and 23

Area of section = 4.8 square inches, $I = 3.8$, $y_1 = 1.083$, $y_2 = 0.0816$, $\rho_0 = 3.47$ inches, $d_t = 1.35$ inches, $W = 14{,}000$ pounds.
Value of
$f_t$ from new formula = 29,200;
$f_t$ from test of specimen = 30,000;
$f_t$ from old formula = 20,400 pounds.

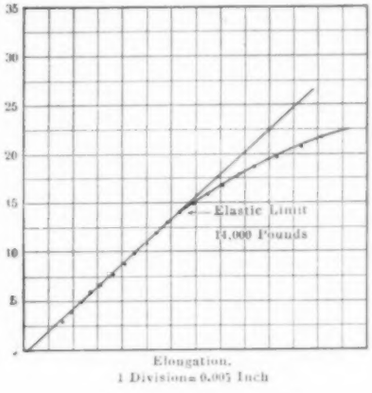


FIG. 19. 5-TON HOOK

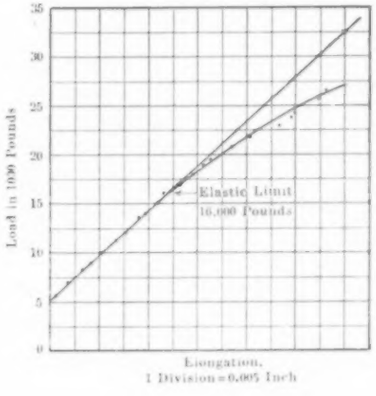


FIG. 21. 10-TON HOOK

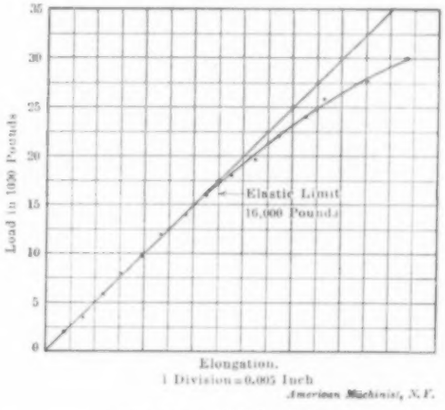


FIG. 23. 15-TON HOOK

STRESS-STRAIN DIAGRAMS OF THREE WROUGHT-IRON CRANE HOOKS

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It is figured that the German empire has nearly 35,000,000 acres of forest, of which 31.9 per cent. belongs to the state. German forestry on scientific lines has resulted in raising the average yield of wood per acre from 20 cubic feet in 1830 to 50 cubic feet in 1904. During the same period it has trebled the proportion of the saw timber secured from the average cut. In 54 years it increased the money returns from an average acre of forest sevenfold, yet today the forests are in better condition than ever before.

## The Picard and Colomb Micrometer

A micrometer-measuring machine, designed by Messrs. Picard and Colomb, has formally been brought to the attention of the French Society of Encouragement for National Industry, whose Committee of Economic Arts, through E. H. Amagat, has presented the following report, which we translate from the *Bulletin* of the society:

The micrometer of Messrs. Picard and Colomb, Figs. 1 and 2, is intended for easy and rapid, yet precise, measurement of the thickness of an object with parallel sides or the diameter of a cylinder. Its arrangement and action may be grasped from Fig. 2.

A micrometer screw $V$ of 1 millimeter pitch, whose nut is fixed to the base of the instrument, moves a piece, ending in a steel-measuring face $T$, whose movement, starting from contact with a parallel fixed anvil $T'$, is given in an integral number of millimeters by a millimetric scale carried on the movable piece and a fixed index which also may be seen in the figure. This arrangement permits the number of millimeters thickness of the object to be immediately obtained. It is then in order to find the fraction of a millimeter to add to this whole number.

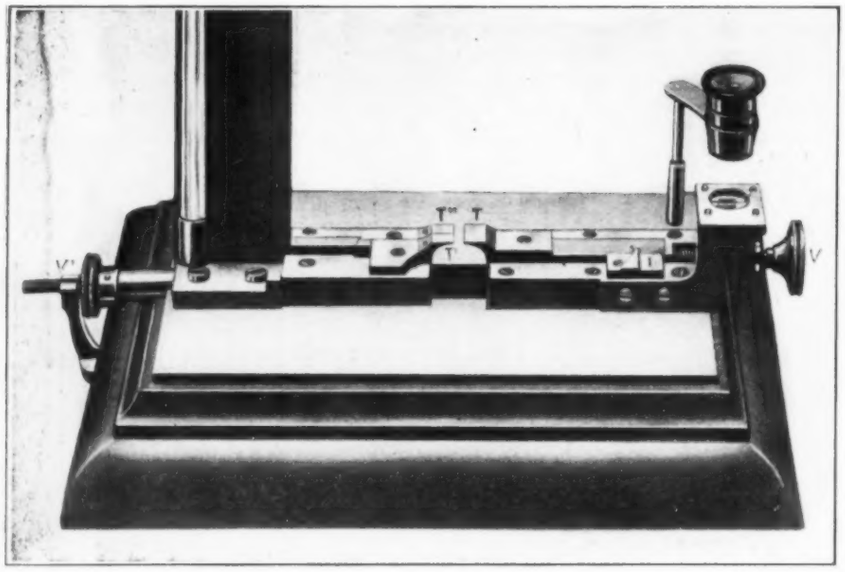


FIG. 1. PICARD AND COLOMB MICROMETER

This result is obtained with a second measuring face $T''$, the edge of which is parallel to that of $T'$. The piece carrying this second contact is held by a spring against a stop, so adjusted that the edges of $T'$ and $T''$ are in the same plane, thus forming a single edge parallel to that of $T$.

The object to be measured is placed between $T''$ and $T$, without encroaching upon $T'$, then the screw $V$ is moved until the fixed index is upon the millimeter of graduation, corresponding to the whole number already determined. It is quite evident that the edge of $T''$ then lies back of that of $T'$ exactly by the fraction of a millimeter that should be added to the whole number.

Let us consider the device invented by Messrs. Picard and Colomb to measure this backward distance.

The body of the contact $T''$ drives a rod parallel to its displacement and ending in a little steel piston, fitting very exactly in a cylinder of the same metal, filled with mercury. This piston drives the mercury into a vertical glass tube of very small diameter, communicating with the cylinder. Its total hight is about 50 centimeters. The hight to which the mercury thus rises above its initial position is equal to the required distance backward of $T''$, multiplied by the ratio of the section of the steel cylinder to that of the glass tube (assuming the latter to be calibrated). On this ratio depends the sensitiveness of the measurement, which thus can be rendered extremely great. In practice, since a tube is never strictly calibrated, we may engrave on a copper plate a scale serving to show the displacement of the mercury, by directly determining a certain number of points, for which purpose we place between $T$ and $T''$ standards of known thickness. The required fraction of a millimeter is read directly upon the scale. It is self-evident that at the beginning of the operation the level of the mercury should always be brought to zero on the graduated scale. This result is attained by means of a second small plunger piston, also of steel, which, by a screw $V'$, is entered more or less into the cylinder containing the mercury.

It is quite certain that, even avoiding the presence of a bubble of air in the cylinder, and perfect tightness being obtained, the hight of the mercury column remains subject to divers causes of variation, notably to those due to changes of temperature, the reservoir of mercury and the rod of glass forming a veritable thermometer. Therefore, it will always be well, and fortunately it is permitted by the instrument, to operate quite rapidly.

The delicate part of these operations seems to be the point of starting the measurement made with the mercury column. Certainly this last measurement, in itself, is susceptible of great precision but do the determination of the whole number of millimeters and the addition of these two measurements reach an equally great accuracy? The following arrangement is intended o take care of this matter: The screw $V$ is provided with a drum, which carries a single mark, to start from the contact between $T$ and $T'$. At each complete rotation, that is to say each time the screw has advanced a millimeter, this mark comes opposite a wire stretched above a drum and whose coincidence with the mark is observed through a magnifying glass. Thus, we bring the exactitude of the starting point of the second measurement to such degree of precision as the micrometer screw is capable of. This dif-

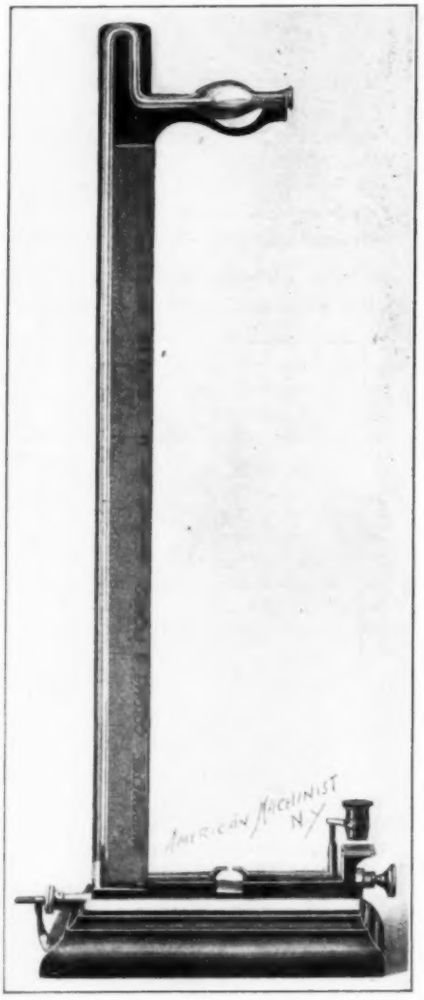


FIG. 2. PICARD AND COLOMB MICROMETER

ficulty, furthermore, disappears if the apparatus is employed only as a comparator, the sensitiveness of the second measurement then taking effect. So it would seem advantageous to determine thicknesses by differences from standards of thickness exactly known.

With the instrument that I have in my hands, the agreement of the measurement made upon the same plate appears capable of precision to about 1/100 of a millimeter. The exactitude of this observation depends, as has already been indicated, upon the use of the instrument not for measuring absolute thickness, but as a comparator. It is possible, however, that by later improvements, among others by regulating the pressure of contact, a greater precision may be reached.

It remains to say a few words on a cause of errors with which the inventors are occupied, viz., those arising from the possible deformation of the body that is being measured under the influence of pressure of the mercurial column. With a view to obviating this difficulty, Messrs. Picard and Colomb have thought that it might be expedient to curve the glass tube so as to render the mercurial column horizontal. I do not deem this complication necessary. If we calculate the compression of a plate a few millimeters thick, having a co-efficient of elasticity equal to 10,000, about that of brass, under the force of a mercury column 50 centimeters high, of course, taking into consideration the ratio of the piston surface to that of the part of the body pressed between the contacts, we find a variation in thickness negligible in comparison with that which may enter through other unavoidable causes of error; and, on the other hand, the fact that a horizontal column is never so well fitted in its receptacle as a vertical column may occasion difficulties very desirable to avoid.

The instrument of Messrs. Picard and Colomb, which is very ingeniously devised, may prove serviceable in many cases, both because of the precision of which it is capable, especially when used as a comparator, and because of the ease and speed of its measurements.

In consequence, your Committee of Economic Arts proposes that you thank Messrs. Picard and Colomb for their interesting communication and vote the insertion of the present report in the *Bulletin*.

This instrument was constructed by the Geneva Watch Company, Geneva, Switzerland.

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The duty on aëroplanes will be 45 per cent. ad valorem, according to a Treasury ruling made public September 3. The new inventions are not mentioned in the Payne tariff law, but under the Treasury ruling they will be classified under the basket clause of the machinery schedule. This is on the assumption that the motor is the most valuable part of a flying machine.

# Pattern Shop Appliances

By James Brown

## Round Steel Dog

There are a number of ways for holding two pieces of wood together while they are being turned in the lathe, but I think the round steel dog shown in Fig. 1 is about the best of any that I know of. Almost every day the patternmaker is called upon to turn up a pattern or part of a pattern in a rush. If it is intended for a split pattern he will, nine times out of ten, use the ordinary pinch dog to clamp the halves together. This is a very dangerous and unsatisfactory way.

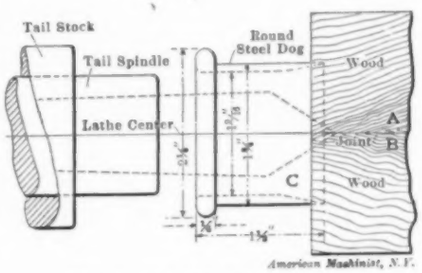



FIG. 1. DOG FOR SPLIT PATTERN

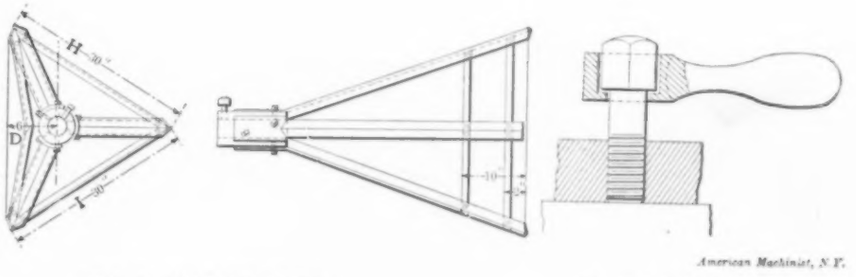



FIG. 3. TOOL REST STAND

FIG. 4. WRENCH

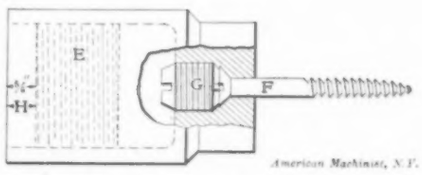



FIG. 2. SCREW CHUCK

I use a pair of steel dogs of the shape and dimensions shown at *C*. They are made of machine steel and are case-hardened at the point only. The two pieces *A* and *B* are put together, a 1¾-inch circle is struck on the ends, and on these circles the dogs are placed and driven into the wood with a mallet. The dogs fit over the drive and tail centers, making it impossible for them to fly off or the wood to shift. The flange ring provides a means for withdrawing the dog from the wood.

## Screw Chuck

I know of nothing so trying on the patience of a patternmaker as a pattern shop not properly equipped with screw chucks for turning small pieces of wood, or if they are in the shop the chances are the screw is too large, or is worn away, or destroyed. To remove and replace the screw might require the service of a machinist.

In Fig. 2 is a chuck that any patternmaker would take a pride in caring for. By removing the screw plug *G* the wood screw *F* can be removed and replaced in an instant. The body *E* is cast iron; *G* is a hardened-steel plug slotted for a large screwdriver; the hole and countersink being made to fit the size screw best suited for the requirements. At *H* the threads are cut away ⅝ inch back which gives a square start to the threads. Screws varying in length from ¾ to 2½ inches are used in this chuck, and the change is quickly made.

## Tool-rest Stand

In Fig. 3 is shown a homemade tool-rest stand made of structural steel; it possesses a number of good points not found in stands that are furnished for this purpose with the wood-turning lathes sold on the market. The head is cast iron 3¼ inches long, with a 1⅝-inch cored hole. The legs, three in number, are made of 2-inch angle iron. The upper ends of each leg are shaped to fit the outside of the cast head, and are bent at an angle that will give a spread of about 30 inches at *H* and *I*. Each leg is bolted to the head with two ¼-inch bolts.

At *D*, which is the front or side next the lathe, it is 6 inches from the center to the outside of the legs. Joining the legs are three stiffeners made from 1-inch angle iron. The front one is 10 inches from the floor and bent as shown; the purpose of this bend being to clear the lathe leg. The other two are 2 inches above the floor, and act as a rest for the foot.

In Fig. 4 is shown a wrench which cannot be removed or lost; when not in use it is moved in toward the stand where it hangs down and out of the way.

This stand can be moved about by one hand; it is light, yet steady and rigid, and will remain where it is placed, not walking all over the floor like a dancing master.

## Correct Metal for Castings

By Almon Emrie*

In the foundry of the Link-Belt Company's Chicago plant a method has been adopted for obtaining the right kinds of metal from the cupola, in the correct amounts, that is simple, and yet largely does away with the element of error.

This foundry is producing miscellaneous iron and steel castings that are used principally for conveying-machinery and power-transmission apparatus. It includes a line of sprocket wheels, the rim and teeth of which must be chilled; many types and sizes of rollers that are really miniature car wheels upon which the treads and flanges must be chilled, together with many other castings which must be hard or soft, depending upon the service for which they are intended. Therefore, it is desirous to have various kinds of metal, varying from hard-chilled iron that cannot by usual processes be machined to a soft gray iron or steel that can be, easily.

This problem of obtaining from the cupola the right kind of material in the correct amount and the assurance that it will be poured into the molds for which it is intended is often a difficult one. To overcome these difficulties the foundry has adopted a system which gives very good satisfaction. The foundry floors, used by the different molders, are each numbered so that the proper amount and kind of metal can be easily carried to the proper floor and poured in the intended mold.

*Superintendent of Chicago plant of the Link-Belt Company.

FIG. 2. BULLETIN BOARD AT TAP HOLE OF CUPOLA

An idea of the system of numbering is shown by the numbers which are hung to the girder or track of the traveling crane, as shown by the letters *F*, *G* and *H* in Fig. 1. These letters number the floors down along each gangway leading from the cupola. Starting at the cupola end, each molder's floor is then numbered 1, 2, 3, 4, etc. Thus, when a certain amount and kind of metal is to be taken to floor numbered H3, J2, or D4, the ladle men know immediately where to go.

In Fig. 1 is also shown the tilting furnace for melting steel. Molds for the test bars of the different metals which are to be poured are located directly in front of the steel furnace and the cupola. These test specimens are cooled and broken so that the fracture may be observed before the iron is poured into the mold. Beside the cupola spout is shown a bulletin

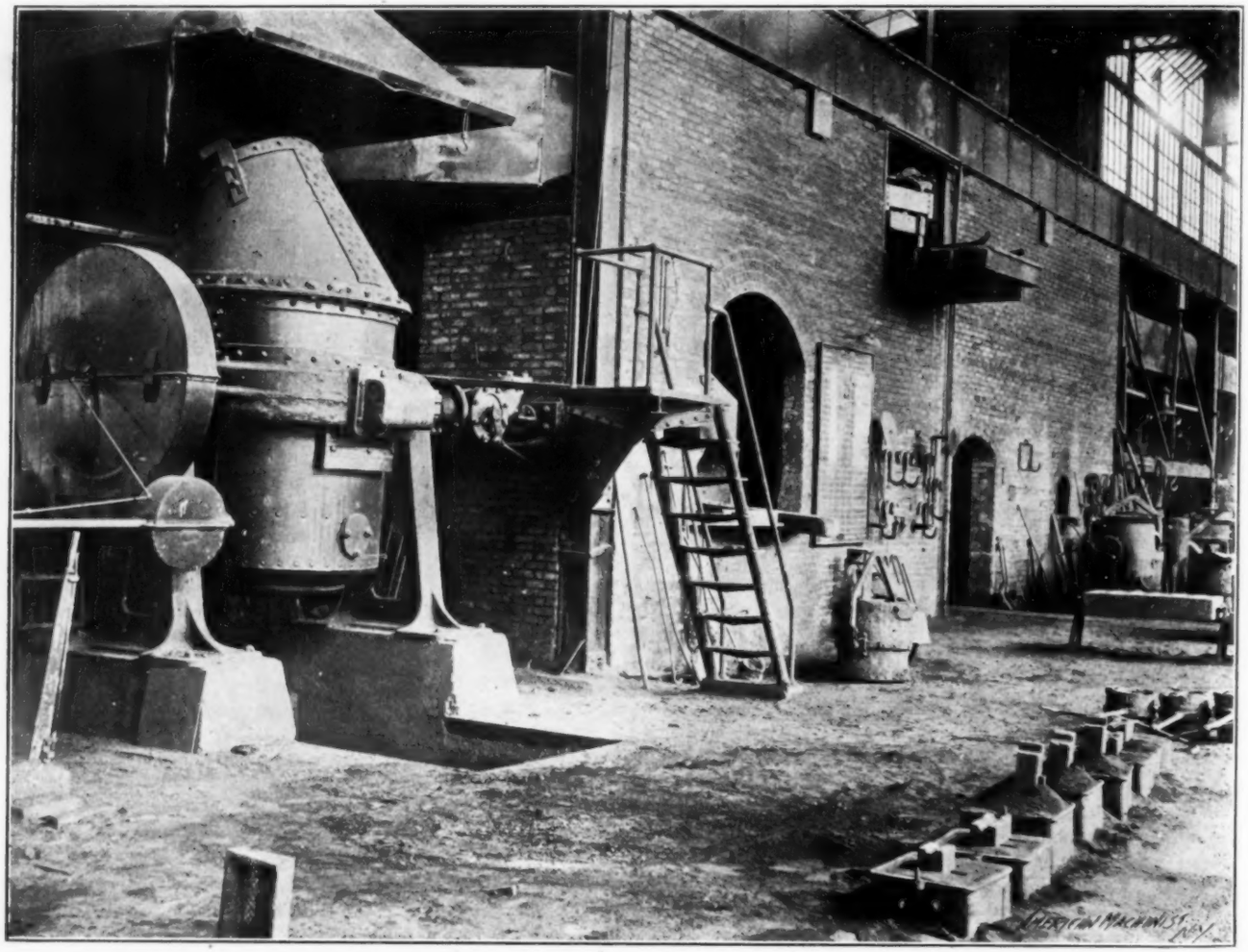


FIG. 1. CUPOLA END OF FOUNDRY SHOWING TILTING FURNACE, TEST BAR MOLDS, BULLETIN BOARDS, ETC.

2-17-09
CUPOLA CHARGES
CHARGE 1-30
PIG IRON
CHARGE NO. | WT. OF METAL IN CHARGE | WT. OF COKE IN CHARGE | STONE IN CHARGE | MERRIMAC 10283 | FEDERAL 19475 | FORGE CITY 69800 | C. Pipe 37.892 | S.B. 32.90 | FOREIGN | RETURNS | STEEL SCRAP | FOREIGN SCRAP | RETURNS | C.I. SCRAP | C.I. SCRAP
BED 4000 2325 30 800
2 4500 46 30 900 600 225 2775
3 3000 310 30 600 400 150 1850
4 3000 310 30 600 400 200 TURNTABLE 1800
5 3000 310 30 600 400 200 1800
6 3000 310 30 600 400 150 1850
7 3000 310 30 600 400 150 1850
8 3000 310 30 600 400 150 1850
9 3000 310 30 600 400 150 1850
10
11
12
13
14
15
23,500 TOTAL CHARGE
METHOD OF CHARGING
CHARGE NO. | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th
BED COKE PIG IRON STEEL SCRAP PIG IRON STONE
2-3 COKE FERRO SILICON PIG IRON RETURN IRON STONE
4-5 COKE FERRO SILICON PIG IRON FOREIGN SCRAP STONE
6 COKE FERRO SILICON PIG IRON RETURN IRON STONE
7-8-9 COKE FERRO SILICON PIG IRON FOREIGN SCRAP STONE
AMERICAN MACHINIST N.Y.

FIG. 3. BULLETIN BOARD ON CUPOLA CHARGING FLOOR

board. On this board is shown the kind of iron that is to come out of the cupola and the amount that goes to each floor or mold, the size of ladle to carry it in, and the floor to which it is to go. Besides this, molds requiring special kinds of metal are given colored tags, so that it will not be poured into the wrong mold. An enlarged view of this board is shown in Fig. 2, and it contains the date of the cupola charge, the time at which the blast was put on, the time the first iron was tapped out, the number of the tap, and the time the bottom was dropped, as well as the total amount of metal run.

The foundry includes in its equipment a chemical laboratory, in which is made an analysis of all the foundry materials, and from here are issued prescriptions for all the mixtures that enter the cupola. That the men charging the cupola may be advised as to the amount and kind of materials to be used, as well as the method of charging, the bulletin board, shown in Fig. 3, is located on the charging floor.

At the top of the board is the date of, and the time at, which to charge the material. In the column to the left of this board is the number of the charge; next comes the total weight of metal used in the charge; following this is the amount of coke to be charged, and next the amount of limestone. In the next five columns are the kinds of pig iron, with the different amounts of each that go to make up the charge, and in the last four columns are the kinds of scrap that are to be used. The amounts of pig iron and scrap used should have the same total as that given in the second column under Weight of Metal in Charge. Underneath this is another table which gives the order in which the different materials should be charged. This bulletin board is made large enough so that the figures can be read at a glance, and the charger know instantly what he should put in the cupola.

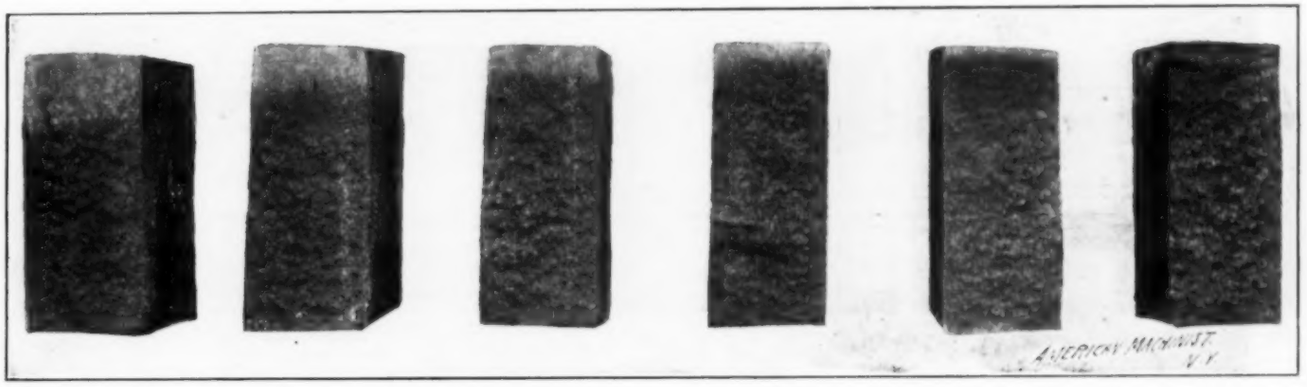



FIG. 4. TEST BARS FROM ONE HEAT, SHOWING CHILL AND TEXTURE OF METAL

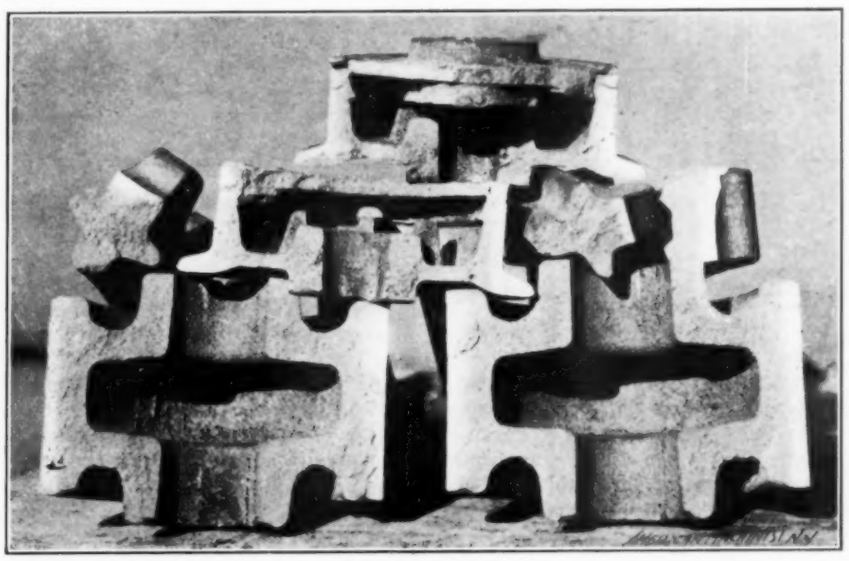


FIG. 5. BROKEN CASTINGS SHOWING THE DEPTH OF CHILL

The texture and the depth of chill of the metal taken from one heat in the cupola are shown in Figs. 4 and 5. Fig. 4 shows test bars which have been broken, and Fig. 5 shows some castings which were broken to see the actual results of the work itself.

# Practical Letters from Our Readers

## A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

## WE PAY FOR USEFUL IDEAS

### Machining of Countershaft Frame

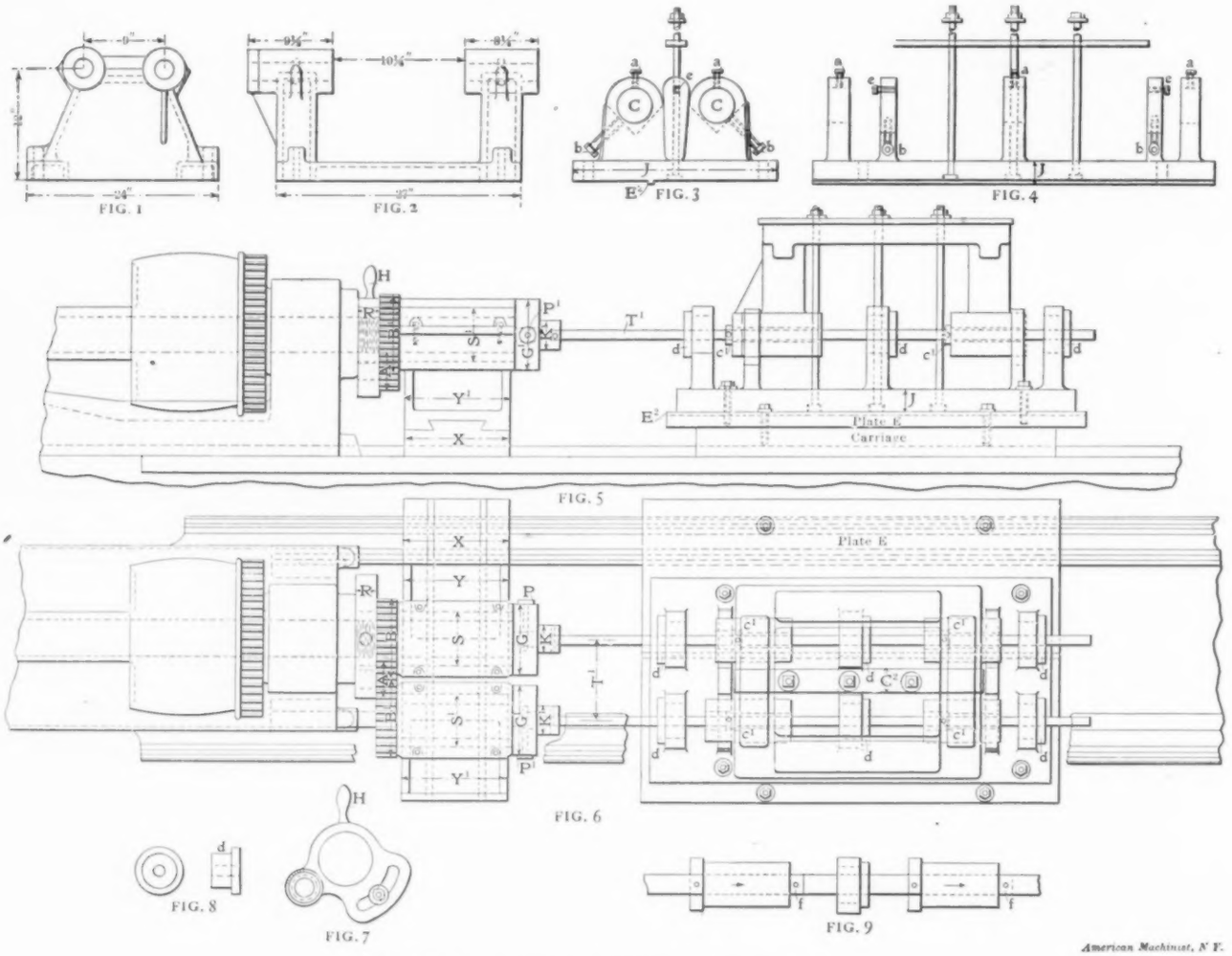
This frame which is shown in Figs. 1 and 2 was an awkward job to handle until we made the jig illustrated in Figs. 3 and 4, and added the attachments to the lathe.

An ordinary single-step pulley Lodge & Shipley lathe was used with back gear thrown in. The bushing or sleeve *S*, Fig. 6, was first made. This was threaded at the end to fit the lathe spindle the same as a faceplate. A reverse plate *R*, Figs. 5 and 6, carrying the small idler gear *A*, was slipped over *S*. The gear *B* was not keyed to *S*. The cross-slide *X*, with the two brackets *Y Y'* dovetailed on it, was lifted on the bed and the sleeve *S* placed in the bearing of the bracket *Y*, and the cap bolted down. The collar *G* was then fastened on the sleeve *S*. A sleeve *S* having the gear *B'* keyed on one end and the collar *G'* fastened on the other, was placed in the bearing of the bracket and the cap placed on. The brackets *Y Y'* were then set the correct distance apart on the slide *X*. This distance varies according to the size of the frame being machined, the one illustrated being the smallest size. Both brackets were then fastened to the slide *X*, and *X* fastened to the bed. The bolts are not shown in the cut. The reverse plate *R* was then moved by the handle *H*, so that the idler *A* meshes with both the gears *B* and *B'*, and bolted in position. This plate is better shown in Fig. 7.

This gives the same revolutions and motion to both the chucks *K* and *K'*, which are fitted in collars *G* and *G'*, and held in position by the tapered pins *P* and *P'*, there being a different size chuck for each size cutter bar used.

A large plate *E* is bolted to the carriage. This plate has a groove into which the tongue $E^2$ of the jig *J* fits. This sets the center *C* of the jig *J* true with the center of the lathe. Several jigs are used on different sizes; all of them are centered by this groove. The jig *J* is bolted to the plate. The bushings *d*, Fig. 8, are placed in position in *J*, as shown in Figs. 5 and 6, and set screws *a*, Figs. 3 and 4, tightened. The set screws *a*, *b*, *e*, Figs. 3 and 4, are left out of Figs. 5 and 6 to better show the frame in the jig *J*.

The frame is set in V-shaped bearings




FIXTURE FOR MACHINING COUNTERSHAFT FRAMES

in the jig and the set screws *b* are tightened. This gives the frame a solid bearing. The set screws *e* are next tightened and the clamps $C^2$ set on and bolted down. The frame is now in position, solid and ready for machining.

The cutter bars *T'* are slipped through the bearings of the frame and through the bushings *d*. The ends of the bars, which are square, are placed in the chuck *K* and *K'* and the pins run through them.

The machine is started and the feed in the apron thrown in. This feeds the frame toward the headstock, forcing the cutters *C'* through the bearings of the frame. In Fig. 6 the cutter is shown part way through.

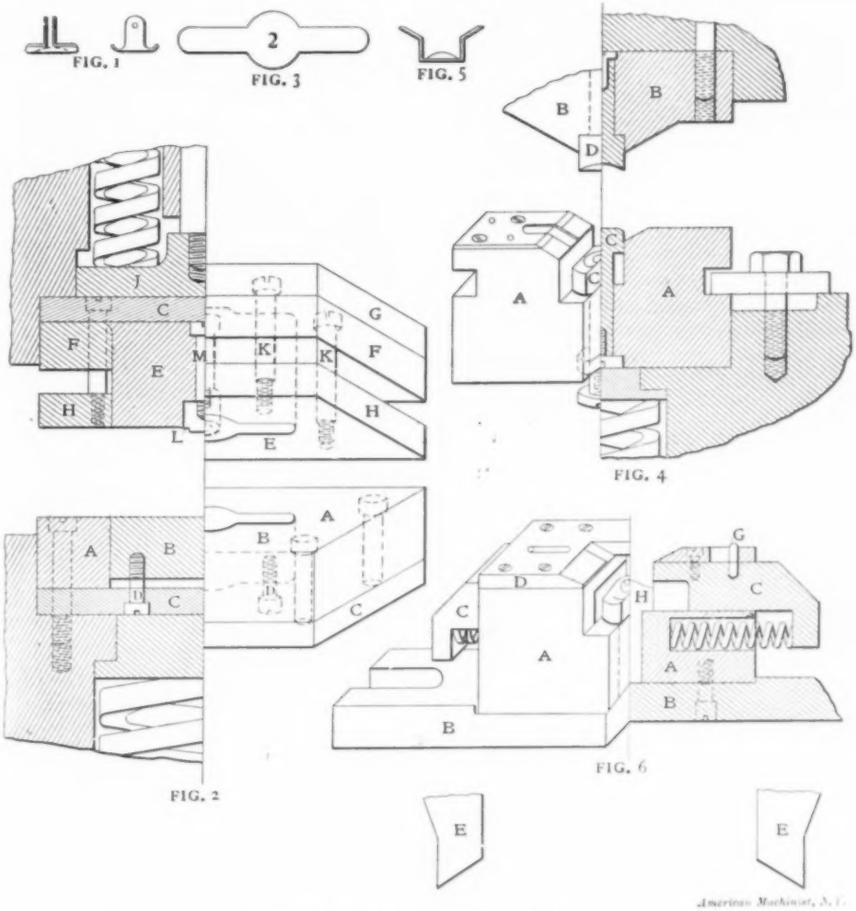
To bore, face and ream the frame ready for use took us about two hours and 30 minutes, which was remarkably fast time considering the accuracy of the work.

WILLIAM H. VICKELL.

Cincinnati, Ohio.

## Blanking and Bending Tool

We had the job of designing the tools for making the button-head end of a lever shown in Fig. 1. The button heads were made of soft, bright-rolled steel, and each one had a number stamped on the top, deep enough to take a filling of wax. This stamping resulted in distorting the blank to a considerable extent. To get over this difficulty the type (or punch with number engraved thereon) was inserted in the blanking punch and allowed to project far enough to give the required depth to the numbering before the blank was cut.




BLANKING AND BENDING TOOLS

Fig. 2 illustrates the blanking tools for use in the sub press and shows a half section with a portion of the sub press. The other half is in perspective. The tools consist of a hardened and tempered die *A* with a hardened and tempered shedder *B*, which also acts as a platen for the type, and a mild-steel base plate *C* through which the pressure pins *D* pass, the pressure being sufficient to hold the stock up to the type before the blank is cut. The top tool consists of a punch *E* fixed in a holder *F*, with a back plate *G* and a pressure plate *H*, which is actuated by the buffer plate *J*, of the sub press through the screws *K*. *L* is the type punch held in position by the screw *M*. When the tools require grinding, *L* is removed and enough taken off the back of it to compensate for the amount removed from the punch. Fig. 3 shows the blank produced with these tools.

Fig. 4 shows the sub-press tools for the first bending operation. They consist of a hardened and tempered steel base *A* and punch *B*. The blank is located by a plate fastened to the top of the die. There is also a hardened plunger *C* to form the head of the button and a hardened inset *D* in the punch *B*. This tool was also used in a subpress, which supplies the shedding pressure to the plunger. Fig. 5 shows the product of the tools.

The second-operation bending tools are shown in Fig. 6 and are made up of a mild steel base *A* secured to the bolster *B* with fillister-head screws, and holding two hardened and tempered slides *C*, which are kept in position by a steel plate *D* and eight fillister-head screws. The slides are actuated by two hardened cam rods *E*, which are held in a steel holder and stem (not shown). The return movement of the slides is accomplished by the springs *F*, the slide working back to stop *G*. A hardened and tempered insert *H* locates the head of the button, the lugs being located by slots cut in the cover *D*. In action the sides simply push the lugs over at right angles, the buttons easily bending at the bend formed in the first operation.

The rivet hole is drilled in a jig, this being found the most satisfactory way, as it is important that the rivet should draw both button and lever end tightly together.

London, England. H. HARRIS.

## A Gravity Cut Lubricating System for the Shop

A shop manager grew tired of his machine hands using drip cans on their machines—he found them dirty and expensive—so he determined to supply lubricant to all his machines automatically. He put a tank about 2½x2x1½ feet on the wall of his shop, about 14 feet from the floor, with a 2½-inch pipe running from the bottom of it the whole length of the shop. From this pipe he had small branch pipes leading to every machine, the ends being fitted with swivel arms and cocks. He then had drain pipes from each machine connected to a 2½-inch return pipe leading to a well in the floor under the tank. A small plunger pump, driven from the line shafting, sucked from this well and discharged to the tank above.

After the bearings are bored to size, the cutter bars *T'*, cutters *C'*, bushings *d* and chucks *K* and $K^1$ are taken out and set aside. Bushings with the size hole of bore of frame are set in place of *d*. Cutter bars the same diameter as the bore are shipped in place of the bars *T'* and chucks to fit the bars are placed in the collars *G G'*. Cutters with cutting faces the diameter of the bearings are placed in the cutter bars, shown in part view, Fig 9. The carriage is fed by hand in the direction of the arrows and the four ends faced off. The cutters are then taken out and placed in slots *f* and the other ends are faced to size.

and so fed the machines automatically. An overflow pipe from the top of the tank discharged into the well. The end of the return pipe to the well was fitted with a gauze strainer to collect any solid matter carried down from the machines. The whole thing was inexpensive, and has paid for itself many times over in the saving of men's time, repair of cans and grinding tools, etc.

Sheffield, England. CONAM.

## Boring on an Adjustable Multi-spindle Drill

A variety of boring operations can be handled to advantage on an adjustable multi-spindle drill when the quantity of similar pieces warrants the time consumed in initially setting up the machine. This is especially true of work that has two or

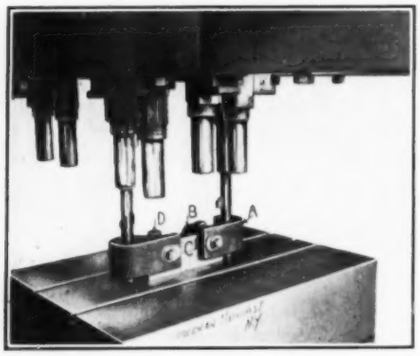



FIG. 1. DRILLING SUPPORTS

more holes to be bored in each piece. The quantity of similar pieces will also determine the number of spindles that should be set up.

The accompanying halftones show the method of boring some engine-lathe parts. Fig. 1 represents two lead-screw supports or trips *A*, which are bolted to a block *B*, as shown, and are located by their tongue fitting a groove *C* in the block. For convenience, a V-block was used, and this is secured to the box table by the bolts *D* and two dowel pins. The boring bars fit corresponding holes in the box table, and are thus held rigid. One roughing and one finishing cut completes the job. The bore is 2 3/16 inches diameter.

Fig. 2 illustrates the method of boring change-gear sweeps. These are fastened by the bolts *A* and strap *B*. Locating pins in the plate, as shown at *C*, center the sweeps true with the boring bars. The purpose of using the plate *D* is to prevent the cutters from boring into the box table after passing through the sweeps, clearance being allowed in the plate. The ends of the bars are supported by the box table as in the previous case. The holes in the sweeps are 3⅛ inches in diameter, and are finished in two cuts, 0.001 inch being left for hand reaming.

In each instance the reason for not

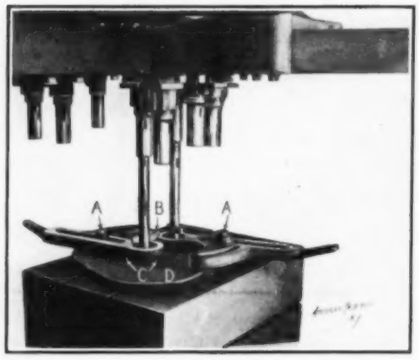



FIG. 2. DRILLING SWEEPS

using more than two spindles was due to the fact, as previously explained, that there were only 24 similar pieces to be bored out.

A three-speed countershaft is required for this work so as to enable the spindles to be run at the proper speed for drilling operations as well. This arrangement also permits tapping to be done, which is an important feature to be considered, since it always pays to tap holes without having to remove the work to another machine. This particular machine has spindles with No. 3 Morse taper holes, and will pull four 1-inch taps simultaneously.

ALFRED SPANGENBERG.

Plainfield, N. J.

## A Boring and Facing Tool and a Patternmakers' Clamp

Fig. 1 is a boring and facing tool, and occupies the place intended for the tool post on an engine lathe. It consists of a cast body of the required hight to bring the cutters on a line with the lathe centers, a binding bolt for securing it to the cross-slide, a facing cutter and a boring bar of suitable size for the work to be done. The facing cutter is secured by a set screw and the boring bar by clamping, as the section of the casting through which it passes is slotted and the parts are drawn together by cap screws. The bar may be adjusted for length as well as for rake of cutter, and either the boring or facing tool is available by slacking the nut on the binding bolt and revolving the holder as you would a turret head. The one shown is in daily use on a 22-inch engine lathe; the cutter bar is 1 7/16 inches diameter by 16 inches long and carries a ½-inch square Novo steel cutter. The facing cutter is made of ¾-inch round Novo steel. The head of the binding bolt fits the slot in the cross-slide and is easily removed. We have also fitted up two other lathes with this device and find it very useful for all work requiring boring and facing.

Fig. 2 is used in the pattern shop when gluing together staves, segments or sections of a circle. It consists of a sprocket chain which is made the required length

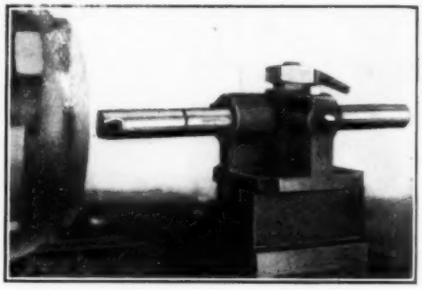


FIG. 1. A BORING AND FACING RIG

by using as many links as is necessary to almost complete the circle and a clamp for drawing the ends of the chain together. The clamp may be forged or made of steel or malleable castings. The one shown is forged from ⅝x1¾-inch iron, and is 7 inches long. One end is fitted to the chain and is hook-shaped to engage the ends of the links without projecting through and marring the work. Near the hook end is an 11/16-inch hole for a ⅝-inch machine

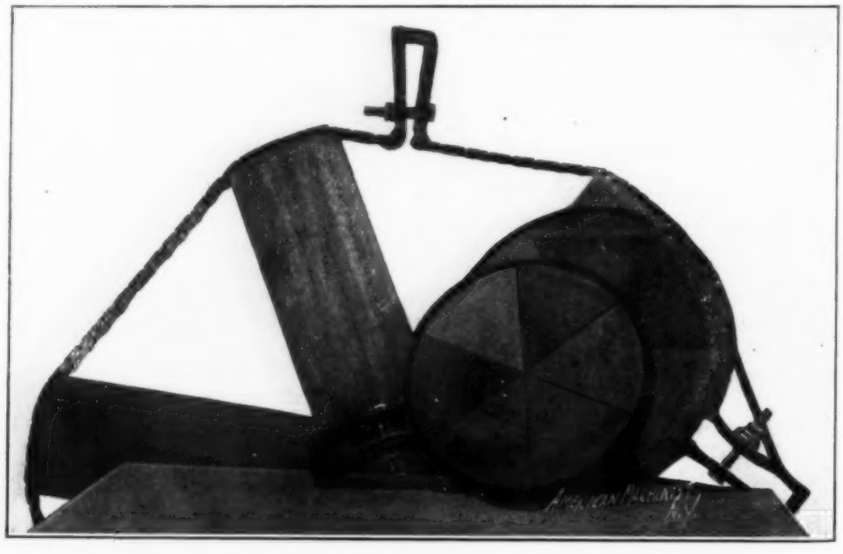


FIG. 2. A PATTERNMAKER'S CHAIN CLAMP FOR SEGMENTS

bolt. The opposite end is bent so as to keep the two parts separated so as to give sufficient latitude in drawing the ends of the chain together. When this device was first made the roller type of chain was used, and I believe it to be the best, but for some unknown reason the ordinary sprocket chain is now in use. I trust that someone else will receive as much benefit from them as we have.

Tecumseh, Mich. DAVIS BROWN.

## A Simple Hand Press for a Special Purpose

The subject of this article for the AMERICAN MACHINIST is a simple hand press for performing the final assembling operation on cash-register keys. A key is made up of a "key ring" which is formed with a bead turned inwardly on one edge and two opposite depressions in the sides; a celluloid disk with the figure or symbol printed on it; a backing disk of thin metal with two opposite sides slightly cut away to clear the depressions in the ring and a stem formed of square or flat stock and having a cup-shaped piece riveted on one end. This cup is formed with depressions to register with those in the ring, and of such a size that considerable pressure is required to close the ring over it. The celluloid disk with its metal backing is gripped between the bead of the ring and the edge of this cup.

Girl operators are provided with squares of wood containing 36 or more shallow holes, in each of which they place a key ring, bead edge down, a celluloid and a metal disk. For obvious reasons, care is taken to have the figured disk occupy a certain position relative to the depressions in the ring as well as relatively the same position as all the others in that block.

The final assembly was performed by a male operator who, taking a stem cap downward in the left hand, would carefully enter it in a ring, lift it from its hole in the block and close the two together with the right hand by means of heavy parallel pliers having a slot cut in one of the jaws to admit the key stem.

The machine I built (see drawing) adapts this operation to female help where it is out of the question to depend on the strength of the operator's hand.

The plate *a*, Fig. 1, of soft steel, is forged with a flat projection on the underside. The steel block *c* is slotted to fit over this and is drilled and reamed for the hardened plunger *b*. The operating lever bears on the end of this plunger through a hardened-steel block *d*. There is also a small pin in the plunger that engages with the lever and keeps the two in contact. In line with the plunger and above its working face is the anvil *e* slotted so a key stem will enter freely and with a slightly raised center position corresponding to the inside diameter of a key ring. Fig. 4 is a full-size top view of a portion of the plate *a*, which is also slotted to match the anvil secured in a slight recess underneath.

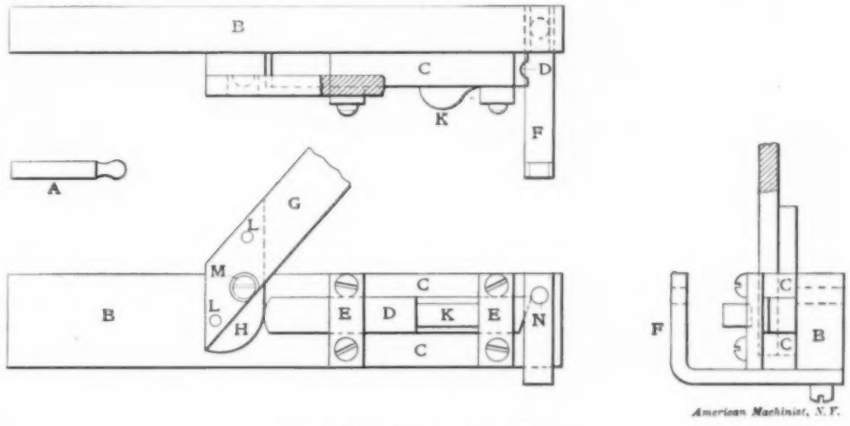
At the bottom of this slot at *f* is drilled a hole. A threaded bushing retains a small pin with a shoulder in this hole and compresses a light spring, as shown by dotted lines. In placing a key in position this pin offers little resistance; yet it is surprisingly efficient as a knockout when the pressure is released.

Dayton, Ohio. M. F. BATES.

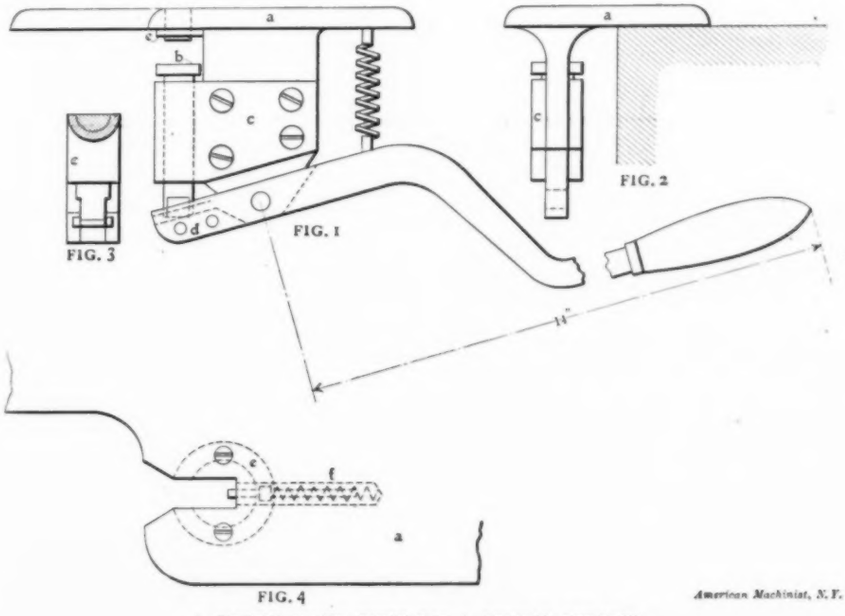
## Forming Pins on the Lathe

In a gas-engine shop a large number of pins such as are shown at *A* are used. They are 3/16 inch diameter.

The heads were previously filed in the lathe. The body *B* of the tool is held in the tool post of the lathe. At the end is the hole *N* drilled No. 11. The support *F* also has a similar hole. *D* is the formed tool which makes the head, the outer edge also cutting off the pins. *D* is held between the guides *C C* and the clips *E E*.




THE WORK AND THE FIXTURE




A SIMPLE HAND PRESS FOR A SPECIAL PURPOSE

*H* is a cam riveted to the handle *G* which pivots on the screw *M*. *K* is a flat spring for keeping tool *D* against the cam.

A long length of rod is held in the universal chuck and the end passed through the hole *N*.

The handle *G* is pulled back and the head formed, the carriage being moved along and the rod being just passed through *F* which thus acts as a support and also as a gage.

D. S. MANN.

## Truing up a Bent Wristpin—Acknowledgment

Due credit is hereby given to Mr. Hamer, of the National Cash Register Company, for the discovery of the method describing a repair job, entitled, "Truing up a Bent Wristpin," published on page 461.

Dayton, Ohio. H. E. CURTIS.

# Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

## WE PAY FOR THESE ALSO

### What is Action of a Lubricant or Coolant?

On page 335, A. H. A. appears to think that the lubricant is wanted at the business end of the tool. This is not so, for the secret of cutting is to have a hard material actually cut or bite into a softer material, then by greasing the two surfaces we take the first steps to defeat our purpose. The man at the bench would not dream of putting oil on his work just prior to filing it for he knows too well how difficult it is to get his file to cut even after only touching the surface with his hand.

The ruinous factor to be dealt with in all cutting tools, taps the worst of all, is friction; this generates heat and the heat ruins the cutting edge of the tools. In tapping or threading with a die we have the greatest difficulty of all, for here we have the greatest proportion of rubbing contact to cutting contact, because it is so difficult to get the clearance or rake necessary without shortening the life of the tool.

In every class of cutting tool made there is some portion of it rubbing the job and not cutting, but just generating heat. A twist drill is rubbing up the side of the hole, more or less, all the time it is drilling, hence partial relief by backing off the drill. The reason we get a better finish on a hole or on a surface with a lubricant is because we eliminate to some degree the friction where the tool is not cutting. We get a better finish with lard oil, or an oil with a good body because the film is more adhesive to the metal and thicker and is not so easily cut by the pressure of the two surfaces, tool and work. As a thin oil forms a thin film which is easily squeezed out causing the two surfaces to seize like a journal without oil and rough up; hence it produces a bad-finished hole or shaft.

I am fully convinced that what is required is a cooling element, just oily enough to maintain a film on the rubbing elements of the job and avoid the consequential heat of dry-surface contact. No greasy matter whatever is wanted where the actual cutting is taking place, for this should and must be perfectly dry. I have often noticed that where a cut has been taken off a job and oil or grease has collected the tool will not cut until the surfaces have been cleaned and are quite dry, which is done by contact of the tool and the material, and by the time this end is attained the edge of the tool has disappeared as well.

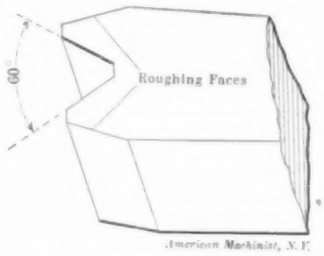
Wilmerding, Penn. F. HAITHWAITE.

### Should Screw Threads Have a 60-degree Angle at Right Angles to the Helix?

This question, raised by L. E. Dudley in his article at page 1045, Part 1, was recently referred to Wilfred Lewis, chairman of the A. S. M. E. committee on standard proportions for machine screws. Mr. Lewis replies as follows:

After giving this matter my attention I was at first impressed rather favorably with the argument advanced by Mr. Dudley.

During my apprenticeship, when I actually had to cut threads on bolts with the threading tool flat on top, and ground to




FORM OF INTERNAL THREAD TOOL

the angle of the helix, with clearance on both sides, I often wished that the top of the tool could be set square to the helix, so that both cutting edges would work equally well. If this were done, however, it can easily be shown that the form of the thread in the plane passing through the center of the bolt, would not be of standard form in that plane, nor would the sides of the threads be straight. They would necessarily be more or less curved by the development of the warped surface in that plane, and admitting this to be a fact, a little further consideration will show that the threading tool used to originate a nut or die to fit the bolt must necessarily have cutting edges which will reproduce a form to fit the bolt. The same threading tool will not do this, and we would be forced to use a tool as shown by the sketch, for producing a thread in the nut to fit the thread on the bolt. This is manifestly impracticable, and the scheme, therefore, cannot be worked out.

On the other hand, when the form of the thread is taken in the plane passing through the axis of the bolt, the tap and die can both be made with exactly the same cutting tool. For another reason also, I believe that taps and dies, made with cutting edges normal to the helix, would not be so well liked in practice, because it would take a good deal more end pressure to feed them than is now required with cutting edges parallel to the center line. As now made the advancing edge is keener than the following edge, and it therefore, feeds more readily in the direction that it has to go.

If the cutting edges were at right angles to the helix and no end pressure was applied in threading or tapping, the tendency would be for the tap or die to cut wide and make loose threads.

I appreciate the difficulties enumerated by Mr. Dudley in accurately measuring and standardizing screw threads, but I believe he will be more successful in meeting those difficulties squarely than in attempting to found a new system in which the difficulties are greater and more numerous.

### Inventing and Patenting

Mr. Smith's discussion of my article on inventing and patenting both pleased me and caused me regret. It pleased me because it showed his interest in the patent subject, and his desire to see a "comprehensive discussion." It caused me regret because of his superficial, yet usual, view of the elements that enter into the real total cost of a patent.

Mr. Smith's contention is, briefly, the cost of a patent is the cost of drawings, Government fees and attorney fees. The contention of my article was that the real cost of a patent is the items mentioned in the preceding sentence, plus the expenditures and work of the inventor leading up to the getting of the patent. The patent itself is what the inventor offers for sale; its cost is the sum of *all* expenditures incidental to procuring it.

It does not seem as if any argument is necessary to show that the latter is the truer viewpoint. The situation is analogous to a consideration of the cost of a machine. The direct cost of a machine is the cost of material and labor entering into it, analogous to the cost of drawings and fees in the case of the patent. Yet we all know that in many cases material and labor combined do not euqal one-half the real total cost of a finished machine. The indirect cost of a machine, the expense burden, is made up of a *pro rata* portion

of the cost of development work, patterns, tools, fixed charges, salaries, etc., and is analogous to the cost of experimental work, models, inventor's time, etc., that are incident to the taking out of the average patent. We all know that the expense is a most important item in the cost of a machine, an item that no manufacturer disregards. Similarly, the development cost of an invention leading up to a patent is an expense which no inventor can afford to disregard, and every inventor or would be inventor should carefully weigh this item when he considers the advisability of procuring a patent on an idea or on an undeveloped invention.

Let us look at the situation from another point of veiw. Mr. Smith says: "The average cost of obtaining a United States patent probably does not run above $150 with a good attorney, and it is doubtful if it exceeds $100." The analysis of the answers to question 1, as shown in my former article, gave an average real cost of the patents investigated of $570. Let us assume that Mr. Smith has a patent for sale which has cost in drawings, attorney and Government fees $150, and work and expenditures on his own part of $420, total $570. Mr. Smith wishes to sell his patent and a manufacturer says: "I will buy your patent and give you 10 times its cost." Will Mr. Smith figure that cost as $150 and ask for $1500, or as $570 and ask for $5700? There is but one answer to this question, and that answer clearly shows the difference between Mr. Smith's position and mine.

In regard to patent attorney's literature, such literature does in many cases give the cost of a patent at $65, as Mr. Smith can verify by writing to patent attorneys who advertise extensively. To be sure, modifying provisions are frequently added as "simple patent" or "applications requiring but one sheet of drawing," but the impression given in many cases to the casual reader, at least, is that the total cost of a patent is $65. Anyone who has had any experience worth while with patents knows that as a general conclusion this is absolutely erroneous, yet a wide acquaintance with men in the shops shows that the popular and general belief is "Oh, a patent costs $65."

The aim of my article was to show inventors, particularly the novice inventors, what the patent game really is, what it really costs, and the chances of success and failure. The real costs are much greater than they are popularly supposed to be, and the chances of success are much, very much, less.

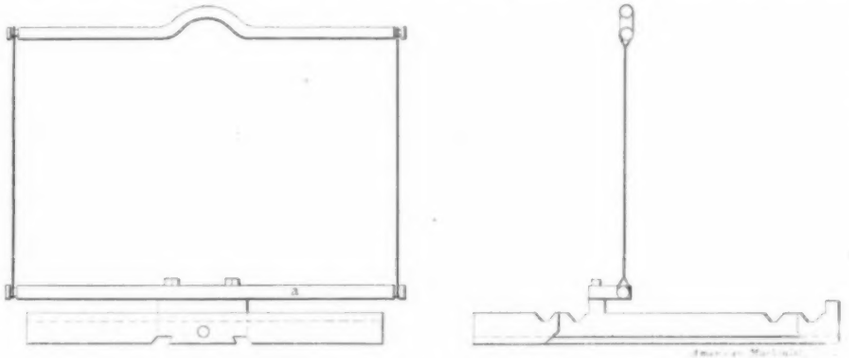
New York City. L. P. ALFORD.

## Operations in Building and Inspecting Lathes

The article at page 225 on "Operations in Building and Inspecting Lathes" recalls some of the same difficulties which I have had to meet. The idea of stringing two rows of beds on a planer and planing all at one setting is good, but I never had much success with forms or guides to set planer tools to. I note that in the Hendey shops they also use sheet-steel gages. If the form is enough then the sheet-steel gages are superfluous. I have had the best results with cast-iron gages with a bearing three or four inches long on the ways, the pair being scraped together. With these gages and chalk marks down the side of the V's, as close planing can be done as can be desired. We simply rub the gage over the chalk marks just as we try a taper shaft in its hole. The sheet-steel gage is all right in careful hands but during the baseball season it is apt to be set a little out of square across the bed. As for roughing out a lathe bed all over before finishing, if the pads for the legs are planed first as suggested in the article referred to and the top then roughed all over and then finished, the only surfaces that can be out of true are these same pads for the legs. Who cares if they are true or not? If one is winding a sixteenth of an inch relative to the other the two legs will not stand true, but neither will they match with each other anyway unless we happen to get a pair that happened to come out of the foundry just alike. When wedges are driven under the feet to level up the bed, all that inequality is taken up.

I also notice the dummy headstock. We used to bolt the real headstock down in place while we scraped the carriage on, but the real reason was that we were in such a rush to get the lathe set up that we began to set up the head as soon as we could get it scraped and bolted on. Of course, we told our unsuspecting looking customer that we did it so that the distortion of the bed due to clamping on the head would be there just as when the lathe was in use, before we scraped on the carriage. If the man looked as if he might ask us why we did not scrape the head down close enough so that it could be clamped ever so tight and not distort the bed at all, or if we thought he might ask how much we thought the tailstock might distort the bed when it was clamped at different places, then we did not say anything about it at all.

We had a scheme for turning over large carriages which is shown in the sketch. We bolted bar *a* to the place where we had a gib on the inside of the bed. The ends were just nicked or grooved roughly in the forge shop to take the loops in the rods that ran to the cross bar, and that was hung on the crane hook. A few pulls on the hoist lifted the carriage clear of the bed, then we pushed it off to one side and swung it clear over and lowered it back ready to scrape. On small carriages, 24-inch for example, our men always laid a board from the end of the bed to a horse and turned the carriage over on that, having to turn it over on only the small width of the cross bridge instead of the whole length of the wings. Possibly the men in the Hendey shops do the same, but the illustrations do not show it. All these muscle-saving schemes pay even if they apparently save no time, for a man who is wondering how long it will be before his back will begin to ache cannot do as good a job as the man who never has to think whether he has a body at all.




RIG FOR TURNING OVER LARGE LATHE SADDLES

Springfield, Mass. ENTROPY

## A Tool for Turning Wood or Fiber

My article on page 376 needs a little explanation. I have access to a number of shops to which the general public is not admitted, the work and tools being of a more or less secret nature. In many of these shops I see small devices which would be applicable to other work. Permission to describe these for the readers of the AMERICAN MACHINIST is often given me but almost invariably with the request, "Don't say where you saw this, or on what work it was used." I never violate such confidence.

The tool shown on page 20 was not used on either wood or fiber but on material somewhat harder than either and not quite as tough as fiber. When I referred to turning fiber I had in mind rough turning and not the splitting of thousandths. If I had accurate turning to do

on fiber, I would go to the nearest working watchmaker and buy for 25 cents or so, an old English watch movement. The jewels in these are generally large white sapphires which are easily secured in a holder and lapped to shape.

I have turned a number of wooden rolls (generally maple) for print works and I still believe the tool shown would do the work I did with a piece of flattened and bent tool steel, and do it satisfactorily.

New York. E. A. Dixie.

## Some Points in the Hobbing Process

I should like to bear out from my own experience one or two of the points mentioned by Mr. Thompson in his letter on page 168. With reference to the torsion in the shafts affecting the correctness of the work, an experience of mine in hobbing worm wheels by the taper hob may be interesting. We had a lot of quick-lead worm wheels to cut in a hurry. The first wheels we cut came off all right, so we left the job to the mercies of the night shift. In the morning we found half the night work ruined, one side of the wheel teeth being deeply scored with V-shaped grooves. The hob was pretty blunt, so we sharpened it and set it to work again, when it cut perfectly. But after two or three wheels these V-grooves commenced to show again. Another sharpening put matters right.

The cause of the trouble was evidently that the power required to drive the blunt hob, when it was roughing out on the taper portion, put such a torsion in the shafts driving the hob that it lagged behind considerably. Then when the lighter cut taken by the parallel portion came on the torsion was relieved, with the result that one side of the teeth was cleared up nicely and the other side left like a ploughed field, where the sharp corners of the tapered roughing portion had been digging in.

I have also seen wheels (worm wheels) in which one side is beautifully finished as a taper hob will finish them and the other side covered with flats, such as are obtained when using an ordinary parallel hob. This has been due to the man stopping the cross-feed when the parallel portion of the hob comes to the full depth in the wheel. The consequence is that the slight torsion in the shafts is relieved and the hob, acting as a parallel hob, cuts on one side of the teeth only. While these experiences are in connection with the taper-hobbing process and not direct observation on spur-gear hobbing, they show that torsion in machines of the generating type must be carefully guarded against.

With regard to the question of flats on the sides of the teeth: The chief cause of these is undoubtedly the inaccuracies of the hob. We once made a hob for spur gears and tested it in the relieving lathe by an indicator. It did not show an inaccuracy greater than ¼ thousandth before hardening. We sent it to an hardening specialist with special instructions to use the utmost care. It came back about 0.002 elliptical and 0.003 wabble in two pitches—the best they could do. If the flats were due to the fact that the hobbing process was not a continuous one, but a "plotting" process, then the flats would increase in size from the base line outward toward the points of the teeth. They don't. Quite large flats are seen near the base line and small ones near the points.

I would suggest that there may be some effect due to inaccuracies in the set of gears connecting the hob spindle with the work spindle—sometimes as many as 12 sets. This would show itself in most cases by a variation in the size and number of flats, on the different teeth of the hobbed wheel. I have observed such a variation but not in the Humphage machine. The hobbing process for spur wheels isn't yet perfect; it depends for its perfection on perfect hobs and perfect gearing in the hobbing machine.

Shiele—of pivot fame—patented a machine containing the germs of the idea about 1856. I suppose it came to nothing, owing to the limitations of the facilities for producing correct hobs and gears. The 1889 machine of Grant's was, I suppose, limited by the same considerations. We are still limited by them. When I want nearly perfect gears at a reasonable price I will plane them with formed cutters made to hand-made gages.

Bristol, England. J. B.

## Machine Control and Levers

In reading the article on page 272 by "Clevelander," I thought it was open to argument. Quoting from the article: "It is nothing more or less than the attempt to do with one handle what is ordinarily done with several. . . . I call it a delusion. There must be something wrong with it even though it is not easy to show where the principle of the thing is awry when it is put into practice." Then after showing how the "multiple-operation handle" was used in the early development of automobile control and now discarded for separate levers: "Evidently the aëroplane is to go the way of the automobile and the other pioneering work of the machine industries."

Can it be any other way, except step by step, with our human limitations, especially in the art of flying where everything connected with it is to be learned? So different and much more complicated than any other navigation!

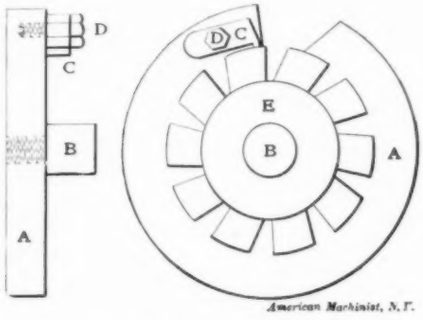
From what I have read a slight movement of the body affects the balance and plane of travel of the aëroplane and every pound of weight is of much importance. Would not this one-handle control appeal to the inventors of the aëroplane, even stronger than it did to the early inventors of the automobile in their experimental stage? Moving it a little front or back, one side or the other, according to which plane he wished to change in unison with the body, or turning the handle for steering, without hesitation, or loss of a movement while looking ahead, instead of reaching and looking to see if you have the right lever.

Again quoting: "The separate levers fit the average man more closely than the multiple one." Also: "It is not always the mechanism that shows up well with the inventor that survives the acid test of general use." Granted both of these statements, but inventors as a rule are not trained mechanics, or average men, but visionary men, with great perseverance and patience, who will try anything that looks feasible, to gain their vision. These are the men who do the pioneering work for the trained mechanic.

Wilkinsburg, Penn. Thos. A. Dicks.

## Gear Cutter Grinder Kink

The article by E. W. H. at page 290 on "Grinding Gear Cutters" brings to mind a simple device of my own for the same




GEAR CUTTER GRINDING KINK

purpose. In the sketch *A* is a round plate somewhat larger than the cutters to be ground and with a notch cut in it so that when the cutter is mounted on stud *B* it allows the emery wheel to grind the face of the cutter in the usual way. *C* is a clamp with a point as shown, held on the plate by cap screw *D*. Now all that is necessary to grind a cutter correctly is to mount it on stud *B* and after grinding one tooth in the usual way adjust the clamp *C* until it will just allow the ground tooth to pass when the cutter is revolved on the stud, and then continue to grind the teeth until they all pass by in the same way. We then have a true cutter.

Albany, N. Y. J. B.

# AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During* 1908 *we printed and circulated* 1,205,750 *copies of the* AMERICAN MACHINIST.

*Our circulation for September,* 1909, *was (weekly, monthly and European)* 111,750.

*October* 7..... 36,250

*This paper reaches* 36,250 *separate readers each month and* 19,250 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*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## Specifications for Buying High Speed Steel

The report that was recently made public, of the Board of Naval Officers that were appointed to investigate the high-speed steel question and see if specifications could not be drawn that would serve as a basis for bids on this product, has brought this question forcibly before the makers and users of this steel. It would seem to be a step toward the standardization of a product that is made in so many different compositions and by so many different makers that it is difficult for the buyers to decide on which is the best for their use. There are several different grades that should be made to machine the different kinds of material and each should be capable of machining its particular material better than any of the others.

The better grades of steel for cutting tools have since the days of Mushet been largely in an experimental stage, as new ingredients, new combinations of ingredients and new methods of heat treating have been developed, that have shown a steady increase in their cutting qualities. It would seem, however, that high-speed steels have now or are fast reaching a place where they can be standardized, and if this is possible the results would be beneficial to both the makers and the users.

The ingredients of high-speed steel are so well known at present that the special secret compositions claimed by some salesmen are looked on with suspicion by those who are informed, and the Government board seems to have decided on the best combination of ingredients for machining hard steel. These ingredients and their percentages, however, should not be made a permanent fixture of the specifications, but should be changed as soon as any definite improvements have been made. For instance, the newer English steels have come out since this board drew up its specifications, and they seem to do better work on very hard material than any of the older brands. They analyze practically the same as the figures given by the Government board with the exception that the vanadium has been increased to 1 per cent. in some of them. The sulphur and phosphorus have also been reduced to a fraction of the figures that appear in the Government specifications. The percentages of tungsten, chromium, carbon and silicon that give the best results in high-speed steels have been definitely decided on, and unless something new arises, specifications for these can be drawn successfully.

In the making of a good grade of steel, whether it be high-speed or common steel, the melting and mixing of the ingredients are as important as the ingredients themselves, as the different ingredients must be added to the bath at the proper time and the whole given time to thoroughly mix in order to obtain a homogeneous metal that has a fine grain or texture. To judge the correctness of the steel in this way, the Government board decided on a minimum tensile strength, elastic limit and elongation.

While these tests will show the strength of the material in certain ways, they are not the same strains that are given to steel-cutting tools. For instance, drills at work are given a combined compressive and twisting strain and not pulled as in the tensile test, while lathe, planer, shaper and milling-machine tools are given a bending and shearing strain to which might be added a vibrational stress, especially when the tool chatters. Any of these tests, however, have very little to do with the cutting quality of the steel, which, after all, is the main thing in high-speed steel, and, therefore, some form of cutting test should be added to the compressive, bending and vibrational tests. Several different machines have recently been put on the market to make the cutting and strength tests that tools are subjected to.

The heat treatment of this kind of steel, as well as of all others, is of as great importance as the composition or the making of the metal, as steel properly heat treated will deliver the maximum of its power when cutting, while if not properly heat treated this will not be approached. In connection with this the forging of the tools is also important.

The Government board recognized these facts, and, therefore, recommended the installation of a central tool-grinding, dressing and hardening plant. While some may think it is difficult to standardize the heat treatment, the fact that this is being done every day in the manufacture of small tools would tend to remove this doubt and argue in favor of standardizing the heat treatment. With the furnaces and forges that can be controlled to an accurate temperature, the numerous instruments for measuring this temperature, the various baths for quenching and the information available for annealing, hardening and tempering all kinds of metals, it is not a difficult thing to standardize heat treatment. Thus starting with a given standard percentage of ingredients the heat treatment that will have the best effect on the composition can easily be obtained and the question of standardization not made as difficult as it might seem.

This being the first attempt to standardize specifications for buying high-speed steel, improvements in them will doubtless be made as time proves the necessity of it. A start in the right direction has been made, and it may be possible in the future to go into the market and buy high-speed steels in certain well known grades the same as we do carbon steels today. The results then would not lie in the skill of the hardener in a demonstration, but in the care and skill used in the making of these steels by the different makers. The

secret composition, which only fools the man who thinks he has the secret, will also be done away with, as have the secret compounds and processes for the hardening of steel or the changing of machinery steel into a hardening carbon steel.

## Robert Hoe, III

By the death of Robert Hoe, III, on Sept. 22, in London, at the age of 70, is marked the passing of another member of that illustrious family so intimately connected with the development of the modern high-speed printing press. Robert Hoe was born in New York City, March 10, 1839, and was the third of the same name. His grandfather, Robert Hoe, came to this country from Leicestershire, England, in 1784, and with two brothers-in-law, Matthew and Peter Smith, started the manufacture of printing presses in 1803. In those days the printing press was a simple device, and compared to modern achievements in this line, an extremely slow one. These men, however, made many improvements in printing machines, each improvement being designed for the purpose of increasing the speed and output of the presses. The first Robert Hoe was succeeded in the business by his two sons, Col. Richard M. Hoe and Robert Hoe, II. Robert Hoe, III, was the son of the latter, becoming manager in 1884.

Credit for the invention and development of the rotary four-, six-, eight- and ten-cylinder presses belongs to Richard M. Hoe, the uncle of Robert Hoe, III. In these presses, which were called into being by the rapidly increasing number of periodicals and daily newspapers and their continuous growth in size and number of editions, the type for the first time was placed on a rotating cylinder instead of upon a flat bed. Impression cylinders were arranged around the main type cylinder, all being set horizontally, and to each impression cylinder flat sheets of paper were fed by attendants, one for each cylinder. By this means four, six, eight or ten impressions from the same type could be made during a single rotation of the type cylinder, and there being no reversal of motion it was possible to vastly increase the speed of printing over what had heretofore been possible. Since that time vast improvements have been made, so that while Richard M. Hoe's press, which was considered the marvel of the day, was capable of turning out 9000 sheets of four pages each, these sheets requiring hand folding or else by the operation of separate folding machinery, the latest developments in automatic rotary presses are now capable of printing, pasting, folding and delivering 166,000 sixteen-page newspapers per hour. This is at the rate of more than 46 complete papers or 736 pages per second. Unlike the original cylinder press, these modern machines receive the paper fed to them in a continuous web or roll, as many as eight rolls being fed into the machine at one time.

R. Hoe & Company have also been most prominent in the development of color printing of all kinds, and scarcely any large newspaper office in the world is without some product of the inventive genius of members of this family. In fact they have manufactured every variety of apparatus connected with the art of printing, though their principal business has been in the line of presses for the great daily newspapers simply because of the greater demand and the continuous call for higher and higher speed.

Robert Hoe, III, was also known as an exceedingly capable business man, as well as an inventor, and he took a personal interest in every detail of development and management. In the large manufacturing establishment on Grand street, New York City, about 2500 men are employed and about 800 men in a similar works in London. It was upon one of Mr. Hoe's annual visits to the London works that his death occurred. For the last five or six years he has been spending six months of every year abroad, occupied in the building up of the English establishment.

ROBERT HOE 3RD.

Mr. Hoe was the author of numerous books on printing and book binding. He was the owner of a most extensive library, whose value is said to be about $1,000,000. The Metropolitan Museum of Art in New York City numbers Robert Hoe, III, as one of its founders. Mr. Hoe is succeeded by his only surviving partner in the business, Charles W. Carpenter, and his two sons, Robert and Arthur Hoe, are also interested in the works.

## Personal*

H. H. Stoeh, for many years editor of *Mines and Minerals*, has been appointed professor of mining engineering at the University of Illinois.

W. M. Corse, secretary and treasurer of the American Press Founders Association, has become works manager of the Lumen Bearing Company, Buffalo, N. Y.

W. A. Jordan, formerly on the engineering staff of S. T. Williams, New York City, has become comptroller of the Charles Warner Company, Wilmington, Del.

C. H. Helvey, formerly sales engineer with the Power Equipment Company, New York City, has recently become secretary of the Republic Motor Car Company, Hamilton, Ohio.

W. E. Tenny, formerly of the Standard Meter Company, New York City, has become connected with the Variable Speed Clutch Company, Milwaukee, Wis., and will be in charge of their New York office.

W. E. Wickenden, at present on the electrical engineering staff of the University of Wisconsin, has been appointed assistant professor of electrical engineering at the Massachusetts Institute of Technology.

Roger P. Redier, commercial manager of Société Francaise de Machines-Outils, Paris, France, sailed for New York from Havre on October 2. His visit to this country is for the purpose of negotiating certain agencies for France, and he may be reached by addressing him in our care.

C. E. Carpenter, until recently sales manager for Schuchardt & Schütte, and W. L. Kerlin, the gear expert of the machinery department of the same company, have resigned their positions to establish a business of their own. Both are well known in their respective lines and the combination promises to be a strong one.

Frank A. Houghton, formerly superintendent of the Richmond works of the American Locomotive Company, and more recently in charge of the automobile department of that concern, has become connected with the Taylor Iron and Steel Company, High Bridge, N. J., and will act in the capacity of general superintendent.

## Engineer Draftsman

The United States Civil Service Commission, Washington, D. C., announces an examination on October 27-28, 1909, to secure eligibles from which to fill vacancies in the position of engineer draftsman at salaries ranging from $1600 to $1800 per annum. Those desiring to participate should apply at once for application form 1312.

*Items for this column are solicited.

# New Tools and Machine Shop Appliances

## Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

## THE LATEST INFORMATION

### The Coit Drill Chuck

There are a number of features in the design and construction of this chuck which attract special attention aside from those which are shown when it is used. A vital feature is the use of the arbor *C*, sired. The ball bearing is back of the collar on the arbor *C*, the balls running between the two hardened washers *G* and the whole bearing held in the body by the nut *H* which makes a dust-proof cover for the working parts. The jaws are free to move radially in the slots in collar *A* as they are moved in and out, while a

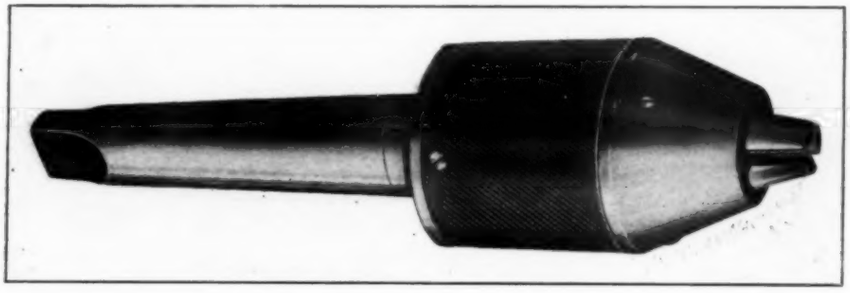


FIG. 1. 20TH CENTURY BALL BEARING DRILL CHUCK

FIG. 2. PARTS OF 20TH CENTURY BALL BEARING DRILL CHUCK

Fig. 2, as a part of each chuck, and having its front end *D*, form a bearing in the body *B*, insuring the body running true at all times.

The collar *A* is threaded on the arbor and carries the back end of the jaws *E* in the slots shown, closing them on the work or withdrawing them as may be desmall screw bears in the slot shown in the lower jaw and prevents the jaws from turning. This makes it easy to replace a broken jaw in case of accident as the chuck need not be taken apart for this purpose.

By loosening the check screw and giving the jaw a quarter turn, it can be pulled out and a new one put in by simply reversing this process.

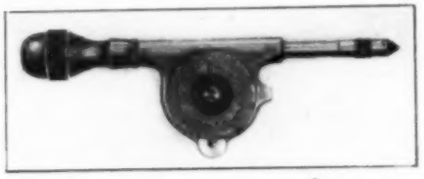
In use, the drill is simply inserted in the jaws, tightened with the fingers to hold the drill so it will not fall out, and started to work. It needs no wrench as it is self tightening, the left-hand thread on the arbor acting on the collar *A* until the drill is firmly gripped in the chuck and body and drill move uniformly with it. And it drives positively, whether the shank is all the way in or not, ¾ inch giving sufficient grip for any drill, virtually lengthening standard drills for deep holes. But no matter how hard the drilling, the drill can be released with one hand and in spite of the positive gripping it does not mutilate a drill, leaving only an indication of the position of the jaw on the shank.

These are known as the Twentieth Century chucks and are being made in three sizes, holding from 0 to 21/64, 0 to 17/32 and from 1/16 to ¾, while a larger and a smaller size will be ready shortly. The manufacturers are the Standard Machinery Company, Mystic, Conn.

### A Convenient Speed Indicator

The distinct feature of this speed indicator is its registering on either side, one side being used for shafts running in one direction, and the other for those running in the opposite way. This avoids errors arising from taking all readings from the same dial.

A small nurled wheel on the side of the case allows quick readjustment after a



CONVENIENT SPEED INDICATOR

reading has been taken, setting the disk that indexes the 100, back to the starting point. This is a most desirable feature when a series of readings is to be taken.

The indicator registers in units, tens and hundreds, is small, light and convenient to handle. The entire working mechanism is incased and fully protected from dirt and injury. The point is hardened steel and easily replaced when worn. The handle is wood and the case heavily nickel-plated with a dull finish. It is made by the Brown & Sharpe Manufacturing Company, Providence, R. I.

## The "Noyes" 60-degree Board

This outfit is designed to fill the demand for an inexpensive, vertically inclined board which will meet the ordinary requisites of drawing room practice, and of the designer. It includes a board sliding at a 60-degree angle, its weight balanced so as to be very easily moved up or down; and the triangular frame shown. This frame may be placed upon any flat-topped table, and is usually furnished with an additional board or leaf which slides at an angle of about ten degrees in the frame as seen in Fig. 2. This leaf may be pushed in so as to allow the board to drop below it, pulled out and the board pushed up out the way. This makes a very handy arrangement when the leaf can be used for figuring and for reference drawings.

The balanced board allows the draftsman to work either standing or sitting as he may desire, and he can always have his work at a hight suitable for comfort in handling his instruments. If it is desired to use interchangeable boards, a sliding frame to which the boards may be quickly attached, is furnished at a slight additional cost. This frame is made regularly to accommodate boards for drawings 24x36 to 36x48 inches, but larger sizes can be made to order. It is made by the Emmert Manufacturing Company, Waynesboro, Penn., U. S. A.

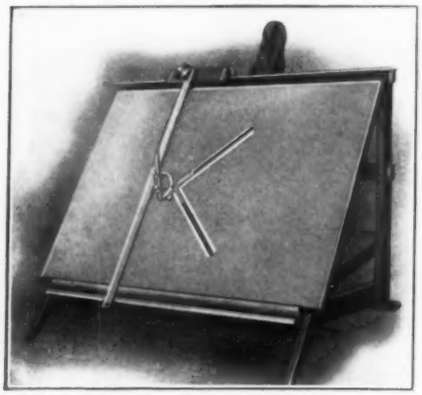


FIG. 1. DRAWING TABLE CLOSED

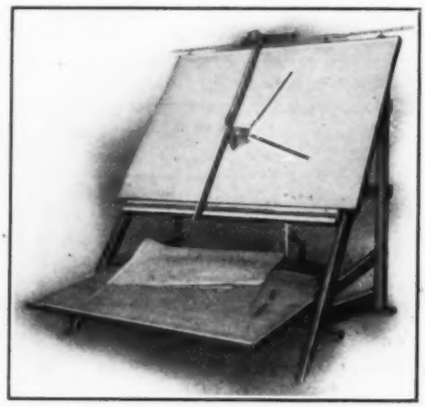
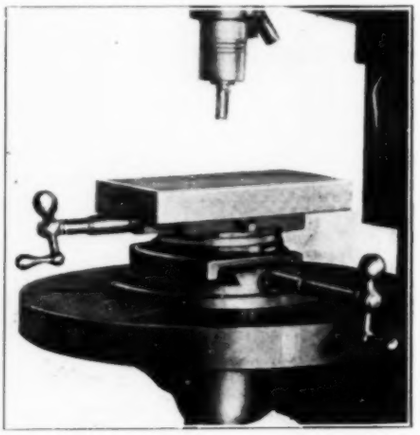


FIG. 2. OPEN FOR USE OF TABLE

## Milling Attachment for Drill Press

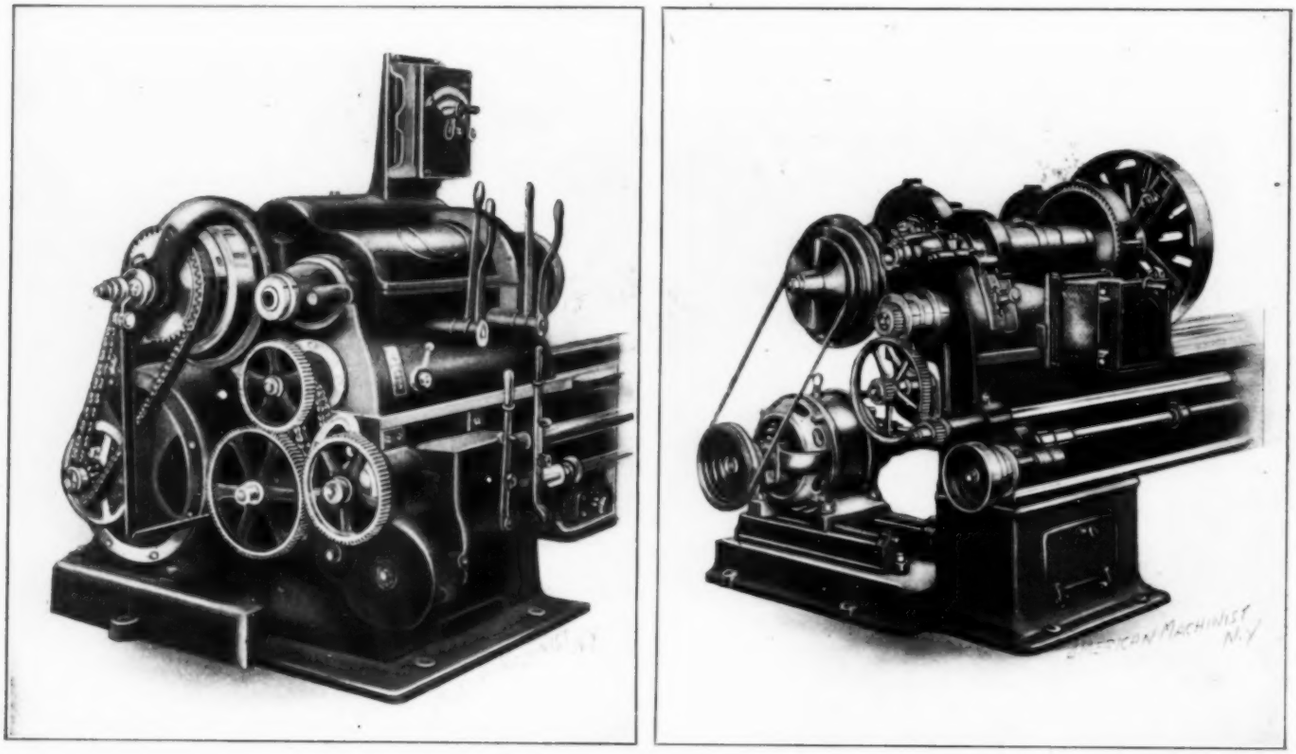
This consists of a circular base for clamping to any drill-press table, and having cross slides in both directions so that the work can be moved under the end mill as desired. It also has a compound graduated saddle so as to secure the exact angle desired in any case and allow considerable milling to be done in case the regular machines are tied up with heavier work. For spotting casting, and small profiling work, it has been found very handy by its builders, the Hinckley Machine Works, Hinckley, Ill. The circular base is 12½ inches in diameter, the cross feeds are about 8 inches each way, and the whole attachment weighs about 90 pounds.



MILLING ATTACHMENT FOR DRILLING MACHINE

## Two German Lathe Drives

The accompanying illustrations show two methods of lathe drives used by Gebruder Dohringer, of Goppingen, Ger-



TWO GERMAN LATHE DRIVES

many. In Fig. 1 power is transmitted from the motor by a pair of three-step cones grooved for a V-belt. The motor is mounted on a sliding base, so that any belt tension desired can be secured. This is evidently driven by a variable-speed motor, as there are few gear changes in the head, in addition to the three steps of the cone.

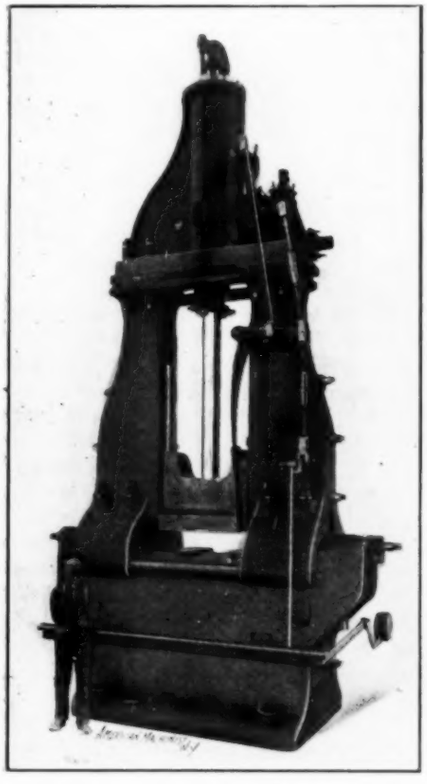
Fig. 2 is a somewhat different arrangement, a chain belt being substituted in the drive, and all feed changes obtained by the geared head with its five controlling levers. The feed box is also geared in this machine, the different feeds being controlled by the two levers shown.

In the case of the V-belt it is rather difficult to see how sufficient power can be obtained with a belt of the size shown, unless there is considerably more speed reduction than is apparent from the gears shown in the illustration.

## New Erie Drop Hammer

The illustration shows a large steam drop hammer, recently built by the Erie Foundry Company, Erie, Penn. This is a 3500-pound hammer, the anvil block weighing 70,000 pounds and the entire hammer 98,000 pounds.

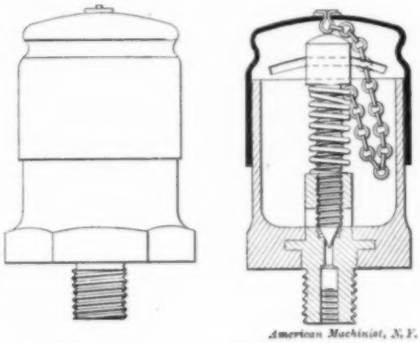
Among the new features of this hammer is a piston stop, placed at the top of the cylinder, which protects the cylinder head against careless handling, and also against damage from the rods breaking or pulling loose from the crosshead. There is a steel tie plate placed beneath the cylinder base and the frames are tied together both top and bottom. There are also adjusting screws at the side which permit of a movement across the anvil, enabling the operator to line up the dies very quickly. Both the ram or crosshead and the sow block are made from open-hearth steel forgings, instead of castings.



NEW ERIE STEAM DROP HAMMER

## Indestructible Oil Cup

While this has been designed principally for locomotive work, it is also equally useful on any heavy machinery operating under similar conditions. The principal feature of this cup is the machinery steel shank which is cast into the base of the cup. This shank has a square collar which prevents it from pulling through or turning, and when the cup is screwed down the square shoulder bearing on the cast-iron part of the body prevents any chance of leakage along the shank.




U. S. M. P. CO., STANDARD NO. 12 CUP SHANK

The body is of cast iron, and the cover of pressed steel connected with a chain to prevent loss should it accidentally jar off. Brass cups are too frequently stolen, and many of the cast-iron or cast-steel cups break off in the shank where this is exceptionally strong. This is made by the United States Metallic Packing Company, Philadelphia Company, Philadelphia, Penn.

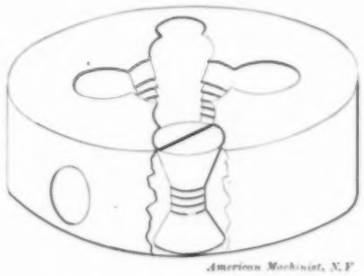
## Micrometer Thimble

The J. T. Slocomb Company, Providence, R. I., is rolling the decimal equivalents of eighths, sixteenths and thirty-seconds on the thimble of its micrometer caliper. This is shown very clearly in the accompanying illustration and gives a complete table of decimal equivalents in a very convenient form.

DECIMAL EQUIVALENTS ON MICROMETER THIMBLE

## The Smart Die Adjustment

These dies are sawed through on one side, while the opposite is drilled out and spring tempered. The adjustment consists of a taper head screw of the proper taper to get a quick and positive adjustment which screws into a cone-shaped nut of the same taper as on the head of the screw.



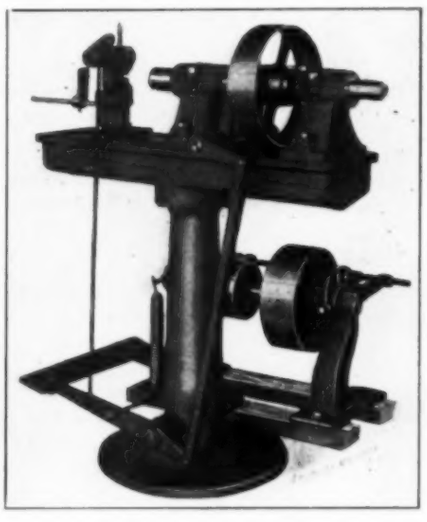

THE SMART DIE ADJUSTMENT

The advantages are that it can be adjusted from the face without being removed from the holder, and that it is expanded uniformly on each side. These are made in 13/36-, 1-, 1 15/32-, 1½- and 2-inch sizes by the A. J. Smart Manufacturing Company, Greenfield, Mass.

## Bolt Pointing Machine

This is for pointing the ends of rods from ¼ to ½ inch in diameter, while bolts or other articles with heads of any shape can be held by recessing the jaws to accommodate the shape of the head.

The operator places the piece in the vise against the stop and presses on the treadle. This grips the work and also brings the cutter head forward against the work until it is pointed, the driving pulley being held against the bearing by the strap and collar. The bearings are large and substan-



A BOLT POINTING MACHINE

tial, insuring long life. The capacity is limited by the ability of the operator in handling the work. It is made by the Webster & Perks Tool Company, Springfield, Ohio.

## Trade Opportunities in India

By M. de Moreira

India, which is not much thought of by many manufacturers, is not, however, a field to be ignored. As a matter of fact this field, though smaller than those of other countries, is nevertheless more varied.

The total annual foreign imports into India according to the latest statistics were $12,347,987, a large increase over the preceding year. This increase is due to the good harvest, to the generally prosperous condition of the country resulting from increasing demands for Indian goods throughout the world, and also to some over trading demands which were indulged in as a result of prosperous times. The increase in exports during the same period should be more or less attributed to the same causes. The share of the United States in the import trade of India rose from 2.3 per cent., equal to $8,300,000, in 1907 to 2.5 per cent., equal to $10,000,000, in 1908. On the other hand its share in the export trade fell from 9 per cent., equal to $52,500,000, in the former year to 7.8 per cent., equal to $45,100,000, in the latter.

One of the best fields in India is Karachi, situated in the northwestern part. Although the figures for the British fiscal year 1908-09 are not yet available, American manufacturers can take the statistics of the twelve preceding months as a gage with which to calculate the demands of that season.

During the year 1907-08 machinery as listed in the following table was imported into Karachi:

| | |
|---|---|
| Agricultural machinery | $5,548 |
| Steam engines and parts | $209,276 |
| Textile machinery | $25,542 |
| Miscellaneous machinery | $476,128 |

Of the imports shown in this table machinery valued at $16,724 was imported from the United States. Practically 80 per cent. of all the machinery came from Great Britain.

The outlook that northwestern India presents to the manufacturers is very attractive as a future market for American machinery, particularly for such articles as gasolene engines, small pumps, windmills, agricultural implements.

### Railways

There are undoubtedly more opportunities for the American manufacturers of railway machinery, etc., in Indo China than in the English part of the territory. Indo China is about one and a half times the size of Texas and possesses several railways. The lines already constructed radiate from Hanoi and Saigon respectively, with a partially constructed line which will eventually join these centers passing through and connecting the isolated ports of Annam. From this trunk a good many small branches are being built and are in need of machinery such as is manufactured in this country. The most important of these constructions is the Saigon and Mytho line. There is another one which goes to Bangkok and which will connect the two important centers, Saigon and Bangkok.

Another line, starting from the coast at Quang-Tri, crosses the mountain range at the pass of Ai-Lao, at an elevation of 676 feet and strikes into the interior of Laos at a certain point on the Cambodia river. Unlike the work done in English India, the machinery used in these enterprises is of very old French pattern and instead of facilitating matters apparently doubles the amount of work needed.

In English India there are now over 30,000 miles of railway and over 2000 under construction. Heretofore all the materials for the construction of these railways were bought in England but lately home influence seems to have little show in India, facilitating therefore competition from other countries.

The railway board of the Assam Bengal railway has allotted $350,000 for new machinery to include twelve engines, six hill section engines and six of the new type tank pattern. The latter will be utilized for "pushers" on the hills and for heavy shunting; also for the newest type of vacuum brake for freight cars, etc.

Street railways have also increased since the Bombay Electric Supply and Tramway Company started a public electric supply over about seven miles of mains in the European section of the city. In Simla, the summer capital of India, work has begun on an elaborate hydroelectric scheme.

In many other parts of India electricity is making practically its first appearance and much machinery has been sold, nearly all of English make; it is well to state here, however, that lately the electrical engineers in India have recommended the purchase of American machinery as superior to that manufactured in Great Britain. To show clearly the opportunity there is there for the manufacturers it is enough to state that during the last year the value of electrical machinery shipped into Bengal was: $613,516; into Bombay, $266,496; into Sind, $47,336; and into Burma $282,240, the other provinces helping to make a total of $1,858,924.

### Irrigation and Petroleum

Another opportunity is in the sale of machinery for irrigation work. According to the official report there are forty-three productive irrigation works in India. All the machinery used so far to dig the canals has come from Great Britain and there is absolutely no reason why American machinery could not be sold.

Machinery for oil boring is also needed. A new company under the name of United Turnyo Oil Company, with a capital of $666,666, has been started to operate near Yinangyaung. India's oilfields when developed will, without doubt, cut a considerable figure in the world's supply of petroleum products. At Kafir Kot this earth oil exudes from brown bituminous sandstone and is found floating on the surface of springs. It is also found at Ratta Hotar hills, at Jobba, of Karsan, west of Chakratta, 9 miles east of Kalabagh; at Dhadur, 3 miles west of Kabbakhi in the salt range; at Narsinghpur, also in the salt range; at Jabba, near Nurpur; in the Algod Ravine at Kafir Kot on the Indus river, and in other places. The Bazar of Dehra Ismail Kahn, on the hills of the Indus, had it for sale as a medicine long before petroleum was discovered in America, or had been developed in Burma. Petroleum was found many years ago in large quantity at a place called Makoom, not many miles from Jeypur, on the Dehing river. But the leads have remained comparatively undeveloped and it is as yet unknown to what extent petroleum exists in India.

In Assam the wells near Digboi are the most promising, a company with $1,550,000 capital operating a large refinery there. There are twenty-two wells near Digboi, but five or six have been abandoned, as they were not sunk to a sufficient depth. However, while the deepest well goes down 1865 feet, it does not yield as much oil as some that are little more than half as deep. The yearly out turn is now about 63 tons of candles, 573 tons of paraffin wax, and 1,200,000 gallons of kerosene oil. Nearly all the oil is sold locally in Assam, or in the neighboring districts of Bengal.

The government statistics do not show the amount of crude oil, refined oil, or paraffin wax derived from the Indian wells; but whatever it may be, there is none of it exported from the country unless it be some of the wax. Burma (really a province of India) is the producer and exporter of kerosene oil and the by-products, such as paraffin.

The petroleum deposits of India, including Burma, have scarcely been disturbed, and the magnitude of the possible trade of India in the products of petroleum can hardly be estimated.

There are six tanneries in India, but although owners have been in the United States to visit various tanneries there is still a good deal for them to learn and an enterprising manufacturer would certainly benefit if he endeavored to place his machinery with them.

### Sugar Refining and Structural Steel Work

A new sugar refinery is being erected

in Bombay and is to begin operation soon. American manufacturers, on account of not having agents on the market, have lost that order in favor of Scotland.

It seems that an enumeration of the various opportunities ought to be enough to demonstrate the variety of opportunities that exist for machinery selling in India. There are many others, however. A steel works is to be established in Calcutta. The new plant is to be located near Barakar and will be uptodate in every respect. A new bridge will be built over the lower Ganges at Sara. A steel water tank to cost $2,300,000 is also to be built in Calcutta and the writer is quite positive that the contract has not been awarded as yet.

Machinery for a hat and cap factory will be needed soon, as such a factory will be built at Bombay shortly; and there are many other opportunities which, for lack of space, cannot be enumerated here. The manufacturer will see by this list that opportunities are numerous.

One word of caution regarding shipping seems necessary and that is that all boxes shipped to India should be iron bound on account of the many thieveries and bad handling of freight.

## "Graduated Stroke" Mortising

By J. Richards

In this country, and to a less extent in European countries, there have been made, during the last 50 years, a great many kinds of mortising machines for wood, called "graduated stroke;" but perhaps not more than two machines of the kind that accomplish what this term really means or stands for. It is not a problem of wood-working—this "graduated stroke" as it is called—but one of geometrical linkage, that may have its place in several arts and so has a proper place among useful problems here.

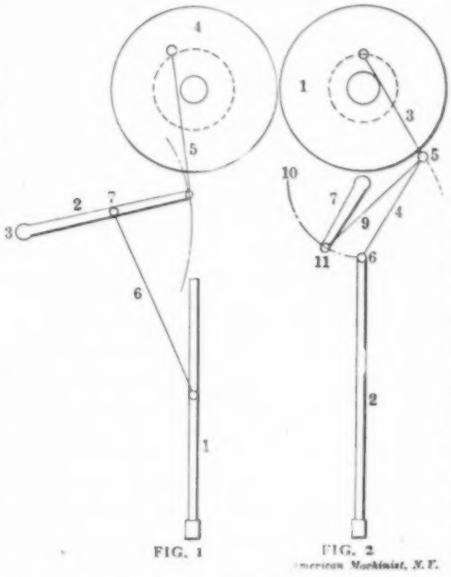
It means, in its use, a reciprocating motion beginning at a still point and gradually progressing in one direction; not a crank motion with an increased throw, but something else that can be understood by the diagram Fig. 1, which illustrates the motion in what is known as the "Lane & Bodley" machines—made by this well-known firm, at Cincinnati, since about 1850 (perhaps earlier than that). At first an uncouth machine for the most part made of wood, but by natural selection it fought its way to a wide sale up in the thousands.

Later it was framed in iron and in the usual course of "evolution" became a respectable-looking structure. It is not quite easy to explain the operation. One of the principal objects in the design of all machines for mortising is to preserve the operator from shock or jar in putting the machines into action—nearly always by means of a treadle because the operator's hands are required in holding and guiding the work.

A common means of avoiding this shock in high-speed machines is by employing a mass of considerable weight, which, by inertia, cannot respond to rapid blows; but this will not apply to deep mortises with wide chisels, so the only machines that are free from jar are those that have a "straight line" connection from the crank to the tools and a crank whose radius is but half the stroke, or which utilizes the whole stroke, and the force on the treadle is taken up by a toggle.

### Principle of the Lane and Bodley Machine

The diagram Fig. 1 illustrates the motion of the most successful machines: 1 is the reciprocating or chisel bar, 2 a vi-




DIAGRAMS OF GRADUATED STROKE MORTISING MECHANISMS

brating lever pivoted at 3 and connected to the crank wheel 4 by a link 5 and to the chisel bar by a link 6. The pivot 7 of the link 6 slides out and in upon the bar 2, producing from a point of no motion at 3 to a full stroke when this link is vertical or in line with the one 5.

The treadle of the machine slides the pivot 7 on the bar 2 by means of proper connections and the proportions are so disposed that the chisel bar 1 is still at its extreme upper stroke and from this point is driven downward to a full stroke of the crank, always returning to its neutral or starting position. In this way the chisel is, when still, always at the surface of the work, and the effective stroke is equal to the crank; also, when the links 5 and 6 are in alinement or at full stroke, all strain is removed from the lever 2 and the treadle and setting gearing.

The original scheme came from the works of a Mr. Guild, of Cincinnati, who applied the motion to a small machine by placing a vibrating lever beneath the floor on which the machine stood—a long link, extending from this lever up to the machine above. Several were made, with so good a result that efforts were made to improve the invention; but for want of an understanding of the principle of acting involved it has, for 40 years or more, remained a special and isolated manufacture. I have in my possession an old daguerreotype of the original machines, too faded for easy reproduction, but indicating the construction very clearly. It is on a silvered plate and was made about 1848.

This seems a simple problem, one of easy solution; but this is not so, because in a long experience I have met with scarce anyone who understood the distinctions and requirements in working; nor can I recall any like case where a simple and highly useful improvement in an implement of common use has remained very near a monopoly in the hands of one firm for so long a time.

### The Principle of the Orton Substitute

One attempt to substitute the "geometry" of this "graduated stroke" by a different linkage was by G. V. Orton, of Cincinnati, about 1866. This device actually accomplished the required motion of the chisel bar and went extensively into use; but it was subject to an impediment that no one was likely to see at the beginning, and not easy of explanation now.

First, as to the Orton linkage indicated in the diagram Fig. 2, where 1 is the crank wheel, 2 the chisel bar and the two links 3 and 4 form the connection from the crank to the chisel bar. This connection is jointed at 5 and linked from there to the lever 7. When the arm or lever 7 is set central, the connections vibrate on the center at 6; the bar 2 being then at its highest point and without motion. When the lever 7 is moved toward 10 by means of a treadle, the points 6 and 11 become fulcra and the bar 2 is set in motion, reciprocating downward. This, too, seems a simple thing; but there is, as before mentioned, an impediment.

As the lever 6 is moved by the foot of an operator, there is a strong thrust on the link 9, that reacts on the treadle, causing jar and disagreeable effort. This could be overcome by the inertia of a balance mass, and to some extent by a frictional resistance to the movement of the lever 7. The latter was tried and acted well, with some limitations. The inertia mass was not tried, so far as known.

For generalization, we must assume that in any machine with this kind of motion, the mechanism that sets the chisel bar gradually into motion must withstand the force of the work done until the connections 5 and 6 in Fig. 1, or 3 and 4 in Fig. 2, come into a straight line. In the case of Fig. 2, we have mentioned means of guarding against this reactive jar; but

it also exists in Fig. 1 and is overcome by a queer expedient, which no one would suspect in looking at a machine. The movable pivot at 7 is in a short sliding saddle gibbed to angular ways on the lever 2. The angle on the underside is made acute, so the force of the blow on the wedging surface prevents the saddle from slipping when the blow is given, but allows free movement except the instant when the blow is given and, of course, prevents shock to the foot of the operator.

## The Science of Selling Abroad

By Archibald J. Wolfe

The secret of a successful export business is in knowing how to sell abroad. The statement is a truism. Yet there is so much light-hearted venturing into foreign markets by manufacturers and others who leave their export business in the hands of persons unfamiliar with the proper methods of selling to foreigners that it would be hopeless to attempt in the limits of an article the enumeration of more than elementary principles which should govern the selling end of an export department. A glance at the daily consular reports, a talk with almost any export manager, a search of the correspondence files of forwarding agents immediately demonstrate the fact that there are but few thoroughly well organized export departments. The best show occasional lapses of judgment arising from the lack of a full knowledge of how to win and to hold foreign markets; those less well equipped continually struggle with the complaints of their customers abroad, or else they merely dabble in foreign business instead of exploiting each invaded market with thoroughness and with a knowledge how to reach the particular trade in a manner most adapted to it.

### Advantages Possessed By Our Competitors

When we stop to consider what advantages our competitors have abroad, in the way of transportation facilities under their own flags, widely ramified banking connections abroad managed by their own countrymen and, therefore, naturally sympathetic and on the lookout for their patrons' interests, tireless workers of their own nationality on the ground, and thousand and odd other helps such as the German and the British manufacturers enjoy in their export trade, many of which the American manufacturer lacks, the wonder is that we have done as well as we have in our foreign business.

### Overdone Self-congratulation

We are, of course, apt to be more proud of mere export figures than actual conditions warrant. It is not enough to know that we have sold more typewriters, or more machine tools of a certain kind, or have shipped abroad so much wheat and corn and oil. In justly estimating our success abroad we must consider what the foreigners buy of us in articles which they can get elsewhere. If a certain patented tool cannot be purchased from any but American makers, there is a certain satisfaction in knowing that we have it and the foreigner has not, yet as an export victory it is not conclusive. But if we offer something that the Germans and the British and the Frenchmen produce and we are out-maneuvered or outbid by the competition and forced to take a back seat there is room for self-analysis, and the answer is generally that in this particular instance we were lacking in knowing how to sell the foreigner, and if we care a rap for our export trade, it is up to us to learn from our competitors and to excel them.

We have a magnificent asset in the glamor attaching to the name "American," which spells excellence in many lines of trade, particularly in hardware and machinery; American safety razors, typewriters, locks, tools, revolvers, agricultural implements, lathes, etc., are famous throughout the world. On the other hand, we must not close our eyes to the fact that American selling methods abroad are accepted by buyers in many foreign lands as equivalent to slipshod, overbearing and inconsiderate. It is not a pessimistic view, but the lamentable experience of every American consul abroad; it is the cry of the majority of agents in foreign markets who honestly endeavor to assist the introduction of American products in their territory.

### The Root of the Trouble

The trouble lies, of course, in the fact that a large proportion of manufacturers regard their export department as a toy, something like an aëroplane, worthy of encouragement up to a certain point as a curiosity, or else they look upon it as a safety isle to rush to when the monster panic bears down upon them and the domestic market is dull, something that may be properly neglected when the domestic market revives. Or again, they look upon foreign business as an opportunity to dump conveniently goods that are not up to the mark, on the theory that anything will do for the foreigners, and that the proverbial farmer's treatment of city boarders is the proper thing to win foreign markets. When they discover that their toy is a less practical venture, as far as results are concerned; or that the supposed safety isle to which they fly in times of depression actually resents being made a convenience of and figuratively kicks them into the gutter; or that their foreign customers refuse to be content with inferior goods dumped upon them, the manufacturers ruminate upon the ingratitude of the foreigners and the vicissitudes of export trade and become disappointed.

### The Study of Markets

Now in a general way the successful method of doing business abroad is to take a particular market and to study its wants; to apply the method of introducing goods to the particular field that is most suited to it; to adapt the goods, if such a thing be possible, to the wants of the market; to take the proper measures for educating the market to the desirability of a certain article, if it be new to it and there be sufficient reason to assume that it is worth introducing there; to adopt such selling methods and credit arrangements, modes of delivery, packing and get-up of the goods that would be most acceptable to the customers and at the same time safe and practicable; finally to devote to the building up and holding of the trade in each market, as much care, forethought, energy, system and integrity as is required to build up the trade at home.

### Foreign Trade Not a Stop-gap

The manufacturer tackling the foreign trade proposition must be first of all honest with himself. Does he or does he not seriously want to get the best results from his foreign trade connections? If he does not, it is best to leave it alone. If his home trade engrosses all of his attention and he is willing to forego for himself and for his successors all the benefits of a steady foreign trade, then it is best not to dabble with it. The results will surely sooner or later prove a disappointment. There are plenty of considerations which should urge the manufacturer of such commodities as may be advantageously used abroad to cultivate the foreign trade, even if the domestic trade at a given time be very brisk.

It is a known fact that there never is a time when every market in the world is suffering from an acute depression. Frequently when the home market has been dull foreign business has kept a factory going. But it happens only in the case of manufacturers who know enough not to queer themselves by neglecting foreign business when the home trade revives. The domestic business may tax the factory capacity, but the manufacturer cannot honestly say that he would not increase his capacity and facilities if it were worth while. Then he may bethink himself of foreign business, perhaps only to find that he had frittered away golden opportunities, but that his competitors had not slumbered. While he hesitated and shirked his chances, while he hemmed and hawed, his competitor gained a foothold and benefited by this significant law of export trade: that the person first on the ground, easily builds up a business, whereas those that follow in the wake have a hard task. Nowhere else is it as true as in the export trade that NOW is the accepted time.

### The Dapper Yankee Salesman

Having then made up his mind to go to

work systematically the manufacturer who desires to do a serious export business will not rush into foreign market haphazard. He will equip himself for it and will refrain from acting as an export-tenderfoot. Merchants in tropical countries are frequently amazed by the appearance upon the scene of some dapper American salesman, attired in Broadway fashion, utterly unsuitable to the climate conditions, without the ghost of a knowledge of the language, the land or the people, rushing in with bungling though daring feet where angels fear to tread. What consul in Spanish-speaking countries could not relate a few tales of such salesmen who make up their itinerary in Cincinnati or Grand Rapids and allot a scant 24 hours to call on the trade of a little town, where a German would stay three weeks and get acquainted and fall in with the ways of the land; but the whirlwind Yankee with only 24 hours on his lightning schedule insists on calling on a prospective customer during the hour of the afternoon siesta, which is as much against the custom of the country, as for an office supply salesman here to break in on the president of a corporation at his home, just as he is about to sit down to dinner and try to talk to him about his line of carbon paper. There are ways of doing things that differ in various countries, and we simply must study them. To offend against them is fatal.

### American Manufacturers too Independent

The American manufacturer is known abroad as the most independent when foreign business is concerned. At home there is too much competition, as well as generally a very thorough knowledge of what is wanted, to permit of a highhanded way of doing things. Any reasonable demands of a customer will be met. But the American manufacturer is too apt to tell his foreign customer to go to blazes, should he ask him to turn out some detail in some special fashion. What are the reasons for this attitude? There are several. First of all in the majority of the cases the export department is there merely on sufferance. The manufacturing end is not in sympathy with it. The factory superintendent, efficient enough in his routine, is apt to consider foreign business a piece of foolishness. "These foreigners are always kicking. They don't know what they want. If a thing is good enough for Americans, it is surely good enough for the foreigner."

This is where a great mistake is made. The foreigner is very apt to know just what he wants, and being unfamiliar with conditions, the factory superintendent is the one who is ignorant. And what is good enough for Americans may be under different conditions wholly unsuitable abroad. Where a little change may be made easily it is folly to persist in a highhanded refusal to comply with legitimate requirements of the foreign trade. Because a thing is packed well enough to reach Columbus, Ohio, it may not be suitably packed for shipment to Calcutta, Lima or Bogota.

A German customer begs that certain fittings be shipped in a separate box from porcelain washstands ordered. "Nonsense," says the packer. "We pack them nicely, fittings and all, for the home trade, why should it not do for Germany?" And as the result the consignee pays an exorbitant extra duty provided for porcelain washstands shipped together with rubber and metal fittings. A Russian buyer begs the manufacturer not to inclose any printed matter in a shipment. "Why not? We make no extra charge." In goes a lot of literature (in English of course, which might have been Hindustani for all the good it does in Russia), and the shipment is held up by the customs authorities, the consignee ordered to pay duty on pamphlets he never ordered and has no use for, and loses a week or so through the delay. Or some advertising souvenirs are slipped in the shipment, with the best intentions in the world, without any extra charge, only the fact is not mentioned on the consular invoice, and the recipient in Brazil is forced to pay a hair-raising fine for a contravention of consular regulations. It is a very safe plan to follow shipping instructions implicitly, giving the customer abroad the credit for knowing what he wants and how he wants to get it.

### Advertising Literature

The question of advertising goods abroad is also of great importance. It is a subject that is wide and important enough to be treated separately. But what does the manufacturer generally do? Outside of advertising in export papers (which for many lines is an excellent publicity adjunct), if he is enterprising enough he translates his American catalog into whatever language is necessary. He tells the tale to the German or the Russian or the Brazilian or the Hindoo in the same phrases, the same arrangements, using the same arguments, as when presenting his case to an American audience. Only the language is changed. This is a sad mistake, for it is easy to figure out that an American could not be won over by the same arguments which may strongly appeal to a foreigner. Judging reversely, is it not worth while to intrust the task of preparing special literature for each market to persons thoroughly familiar with them? One manufacturer of suspenders issues a series of photographs of the wives of American presidents as premiums. He considers that a specially telling inducement. But while this may arouse great interest in New England, it will surely fall flat in Nizhni-Novgorod. Terse, striking, slangy and pithy sentences of these catalogs when translated into stately Castilian sound crude, barbaric, helpless and witless. In this particular error even the most prominent and otherwise very thoughtful manufacturers have defeated the usefulness of their own foreign campaign literature.

And right here it may be said that tons and tons of American catalogs are wasted annually. Thousands because they are in English; this is as foreign to a Brazilian, as Assyrian would be to a farmer in Iowa; other thousands because they are sent to addresses culled at haphazard from foreign directories or sent to lists of names compiled by irresponsible parties; many others because they do not contain prices; others again because they are ineffective, being translations from matter compiled for home consumption. On the other hand some manufacturers go ahead intelligently. If they tackle China they do not send catalogs with long technical descriptions or chemical analyses, as some manufacturer of breakfast foods attempted to do when he meant to tell the Chinese how much proteid or what-not was contained in them. They issue posters specially gotten up for the Chinese tradé, brightly colored, with a pictorial representation of the article and its uses, giving a full illustration of the package. This is what the Standard Oil Company does when advertising oil and oil lamps in China; this is what a certain biscuit company is doing when advertising its brand of biscuits.

### A Case of Demonstration

Many articles must be introduced by actual demonstration. For years the merchants in Manila were in the habit of locking their stores with clumsy locks, the keys to which weighed from one to five pounds. When the Americans invaded the islands they ordered some Yale locks from home, and their practicability soon commended itself to the Filipinos and the Spaniards. Now years of advertising these articles would not have done one-fiftieth as much good as a few object lessons demonstrating their utility in actual use. The same thing applies to many, nay to most other markets, where American articles of utility are either altogether unknown or insufficiently known.

### Credits

There are rich and promising markets which the Americans are loath to touch or to work in any way thoroughly: Asiatic Turkey, with its magnificent opportunities; India, with its boundless millions; the Balkan states; Siberia; the interior of China. Most manufacturers demand cash in New York for their goods and refuse to do business on any other basis. Of course, this is safe, but there are ways of granting credit to thoroughly solvent houses which are as safe and profitable as granting credit at home. There are tropical countries where settlements for crops are made once a year. To force importers in those countries to pay cash in

New York, perhaps forty-five days before the goods reach them, is to limit their custom to staple goods which need not be examined and also to goods they cannot purchase from the Germans, the French or the English, who have banking facilities on the ground and are willing to grant such credit as is necessary. If it were not safe, these manufacturers in competing countries would not grant the credit.

We have only touched on a few features of the science of selling abroad. Our manufacturers will have to master it before they can *conquer* foreign markets.

## Why Manufacturers Dislike College Graduates*

By Frederick W. Taylor†

The educational question interests me entirely from the view point of the user of engineering graduates and not from that of the profession. It has been my good fortune to have the training of several hundred engineering graduates and, therefore, it must be apparent that, in the criticism which I have to offer regarding the young men, I am not opposed to engineering education as a preparation for life. On the contrary, in all cases where possible, I invariably select an engineering graduate for almost any large position which needs to be filled. I want to make the matter perfectly clear because in the kind of criticism that I propose to present, one is very apt to be led to the conclusion that I am bitterly opposed to the engineer as he is now trained.

As to the value of the young engineers, there ought to be no question in the mind of any impartial investigator as to the enormous value of an engineering education for success in actual, practical life, in commercial life, in manufacturing life, and in engineering life. On the other hand, I think probably you gentlemen are not in very close touch with the general public opinion of the country as regards young engineers.

You are many of you inundated with letters asking for the services of your young graduates, and from these it is perfectly natural to suppose that the country at large wants them very badly. Now I do not think there is a shadow of doubt but that the overwhelming majority of employers of this country want to have nothing to do with them if they can help themselves. That is a fact, and I think it is one that you gentlemen ought to appreciate as having a great bearing on the educational problem. Mr. Crane, of Chicago, has very aptly represented this type of men. He stands, however, almost alone in representing this view, and I have heard Mr. Crane laughed at, sneered at and held up to ridicule to such an extent that it appeared to me that Mr. Crane's view of the matter is hardly even tolerated by the men who are engaged in university teaching, whereas he is voicing the view of the great majority of the employers in this country. They say nothing, but they agree over and over again with Mr. Crane. I want to give one illustration of this. I was recently in the middle West at one of the largest and most successful manufacturing companies in the country. They had present some thirty of the heads of their departments, their president, vice-presidents, general manager and superintendents, and after I had said a few words in regard to the fact that there were so few college employees in their organization, the president of the company, who was a college man himself, rose and said, "Well, this is an entirely new experience to us. Here is a man for whom we have a certain regard, and who has the reputation of being a practical man, and he tells us we had better use the college man instead of the commercially trained man." They almost all laughed, although there were four college men among them, and those four were as firmly convinced of the inutility of the college man as any of them.

I want you to appreciate that that sentiment exists right now, very largely in this country. I think those who have had the longest and largest experience with them want them the most, but I dare say, they only want them on the average after they have been out of college for one or two years. They want someone else to take them first.

There is one exception to this not wanting to employ college men which is quite prominent. The large electric companies are employing them on a large scale, but it is my opinion that they are, to a large extent, exploiting the young men; that the opportunities which they get in the large electric companies are in no way comparable to the opportunities which would be open to the same men if they went into smaller industries with their greater diversity.

Now that is one side of the question. The other side comes to me from my personal observation. I think it is also true that nine out of ten of these young men are dissatisfied for at least one or two years. They find their employers unappreciative and exacting. They are not given any kind of opportunities commensurate with their education and what they are able to do. They are asked to do work that mere boys could do. Almost invariably, they want to leave their first employer, and it is only after going to their second or third that they become aware of the fact that the boys that they make light of are the ones who can do things and are the ones favored by the employers, and that the whole or nearly all of the employers of the country are not really unappreciative. Some ten years ago I made up my mind never to employ a college man who had not been out two years at least, if I could help myself. Then he will have learned something about life and what the world is.

Now are those two conditions indispensable? Are they indispensable conditions to the young graduate? Is it necessary that the young graduate should be turned out so that he is unhappy and discontented for a period of two years more or less after he graduates? And is it necessary that the young graduate should go out with such an education that the average employer, who is an honest man, who really believes that he is right, feels that these young men are not what he wants. Is that condition indispensable? I most firmly believe not. I believe that the young graduate can be turned out so as to be useful right from the start, and I believe that there are two particular faults which are responsible for this condition of affairs, both of them remediable.

The first of these is because of the fact that during the four years that these young men are at college, they are under loose discipline, and are allowed a greater freedom than they have ever had before, or will ever have again.

I will cite some illustrations. In most universities and colleges the student is given, every term, a certain number of cuts for which he is held to no responsibility. He can simply absent himself from recitations, from lectures, from duty that belongs in the college course, and no one ever asks what he has done, or where he has gone. If that same young man absents himself once without a reasonable excuse, when he gets into business, he is usually hauled up and asked in the most impertinent manner, why he was away. No cuts in business, no talk about how many cuts a man has. The second or third time that he does cut, he is discharged. Young college men work when they please and as much as they please, the only restrictions being that they have to pass certain examinations. Their habits are left almost entirely to themselves. When they begin commercial life those habits are regulated and rigidly prescribed by someone else.

The radical difference of treatment which these young men receive in college, from what they receive afterward, to my mind, is the lesser of the two reasons for the two fundamental facts that I have described, namely the unhappiness of the young man when he gets out, his failure to fit in his surroundings, and great lack of demand for these young men throughout the country.

The reason for this is that for twenty-two years these young men are allowed to go without even a single look at conditions which they are to face throughout their lives. The work of the student, of the young man, is that of absorbing; he

*Condensed from remarks made in discussion before the Society for the Promotion of Engineering Education.

†Past president, American Society of Mechanical Engineers.

is engaged in the performance of getting things fastened in his mind for himself, for his own use. That is his life for twenty-two years. The moment he gets out he begins directly the opposite. Absorbing ceases and becomes a very minor part of a man's work. He begins giving the few ideas, or the many which he may have gotten, to help someone. He has been served for twenty-two years by someone else, the moment he gets out he begins serving others. Is it any wonder these young men find great difficulty in suddenly changing from the attitude of sponges, or absorbers to that of human beings actively engaged for the benefit of someone else? I think the wonder is that they adjust themselves so quickly to it.

The central idea that the boy gets at college is training, training of the mind, storing the mind full of things. Now I say without the slightest hesitation that for success in life intellectual training comes second or third. Without the slightest question character comes first, good sense, second, and intellectual training third. The entire emphasis of the college is on intellectual training. As long as the man commits no offense which sends him to jail, it is very little of the business of the management of those universities what those boys do.

What is the remedy for these two faults? I do not believe there is any panacea for all faults, but I do believe that there is a great palliative possible. I believe that every young student in our colleges, from the student who intends to be a minister on the one hand, to the mechanical engineer on the other hand, should leave college at the end of the freshman year and spend at least one year in actual hard work in a shop of some kind. I say shop, because he will be certain to be under careful and constant supervision when working in a shop as a workman, alongside workmen.

I would not send them there with the idea of getting intellectual training. If they do, it is a mere incident. I would send them there mainly for the purpose of giving them a real look at life's work and give it to them early enough so as to affect the last three or four years of their college life. When they start work in a shop, under good rigid discipline, they then begin to get the character training which is almost entirely lacking at college. They then begin to learn the great lesson of life that almost nine-tenths of the work that every man has to do is monotonous, tiresome and uninteresting. Then they start to develop the character which enables them to do unpleasant, disagreeable things. This is the greatest training, to my mind, which they get in the shop. They learn that life is made up mainly of serving other people, not that the world is there to teach them something new. I think that almost invariably they start into the shop with the common idea, "Now I am here to learn something, to get something in this shop that is going to be a fine engineering education for me." They fail at once, for there is no great intellectual training in the shop. Many of them cannot stand the monotony and fail to get the real character training that comes from that work.

There is another thing that they learn, which is of enormous importance for these young men, and I think it has more to do with making them earnest and determined than anything else. You could lecture to them and talk to them from now to doomsday, and tell them that the man who goes along the street in greasy overalls, that the man who runs a lathe, is mentally as well equipped as they are and they won't believe it. They may acquiesce mentally, but away back in their brains they say. "Oh, yes, I will believe it, but it is not so." That is their mental attitude.

Young men who work in any first-class establishment find that men who cannot talk grammatically, that men who chew tobacco, slouch along the street with greasy overalls on, who hardly look up, who are scarcely willing to speak to you politely as you go along, are intellectually as clear as they are. That is what the young men learn. I remember very distinctly the perfectly astonishing awakening at the end of six months of my apprenticeship, when I discovered that there were three men in the paint shop, I being the fourth, who were all smarter than I was. Now when a young man gets it clearly in his head that he is made of the same kind of clay as those other men, then his only hope is not to be outstripped in better education. He sees clearly enough, if he uses his eyes, that it is energy, grit, pluck, determination, ability to stick to it, character which makes success in the manufacturing and in the engineering world. He will finally come to the conclusion, "I can get that as well as the other fellow, I have as much grit, I can probably get more." He probably has more, and he goes back to college with the determination to get the better education.

This development of character I look upon as the greatest good that comes from work in the shop. Professor Furman, of Stevens Institute, published last winter, in the *Stevens Indicator*, a record of the careers of the graduates of Stevens Institute. In the group of successful graduates of Stevens Institute more than half were engaged, not in engineering, but in executive work, in managing as presidents, vice-presidents, superintendents, managers, in some capacity in which engineering was entirely secondary and incidental, and in which the real work was executive work. Now that is a very important fact which shows what has taken place with the graduates of one of the oldest mechanical engineering schools of this country.

At college a very large amount of time is given up to the study of materials. Practically his whole chemical course is the study of materials. A very considerable part of his course in physics has to do with materials. The greater part of his work in a mechanical laboratory is a study of materials. Do you, gentlemen, realize that the great raw material with which more than one-half of the successful graduates of our technical schools have to deal receives not a single hour of study at our colleges and universities, not one hour? That the great raw material with which the managers, superintendents, presidents, every man of our large companies is dealing is men? And these one-half of the students who are finally called upon to manage workmen, learn nothing whatever about that at college. At 22 years of age on the average they land outside of college without the slightest knowledge of the great raw material with which more than one-half of them will have to work throughout their lives.

Now, those of you who have worked much with workmen, will realize fully that it is next to impossible to study them from the top. Workmen can only be properly studied side by side and shoulder to shoulder. The man who undertakes to study them from the top, gets a superficial knowledge of his workmen, and in many cases an entirely wrong and misleading idea. The only way that a man can become familiar with the line of thought of his workmen, with the process of reasoning by which they approach the great problems that are in their minds, is by becoming intimate with them, by working side by side with them, so that they forget that you are not one of their kind, and genuinely tell you what they think.

I say without the slightest hesitation that no man is well equipped to manage workmen who cannot say ten sentences consecutively to a workman and have that workman say at once, "Oh, he has worked. I know about him. He has worked." Absolutely, unconditionally in ten ordinary sentences, if it be about work, the workman will size up the fact as to whether he has been a workman or not. And until a man is intimately acquainted with them and knows their methods of thought, their methods of expression and the way they look at things, he is at a very great disadvantage as a manager.

Just now, in this country, we are facing a great problem in the management of our men; the problem upon which, I think it may be said with almost certainty, that England has made a grand failure. We are facing that problem and are up against it hard; the problem of soldiery, and no man can properly and thoroughly appreciate this great problem unless he has worked among men when they soldier, knows their arguments for and against it and has some idea of how to remedy that great defect; the defect which has come close to ruining the English industries.

Now there is one more thing. More and more, management is becoming a question of coöperation on a large scale. The whole training of the young man while he is at the university is an individual training. He has not the slightest training in coöperation, except possibly what he gets from his baseball or football team in the university; and yet every year the problem of coöperation becomes a greater one.

These young men at twenty-two go out without having seen any coöperation, thoroughly unfitted for it in many respects; thoroughly unfitted to do what they are told promptly and without asking questions and making suggestions. They will not become one of a train of gear wheels, and it is absolutely necessary for every man in an organization to become one of a train of gear wheels. The training he usually receives in no way fits him for that. But the year in a shop will give him at least a good look at it. He has to work as one of a train of gears during that year. I do not think there is any equivalent for this work. Certainly the university shop is in no wise an equivalent. There they are in competition, not with men who are engaged in working for a living, but with other students. They are not rubbing against other men and getting their viewpoints, learning something as to how work ought to be done. They may get a little good out of it, but as far as the great work they ought to have, the character training and the study of men, they get nothing. The thing that comes close to it in college is the three or four months of vacation work. Even during this time, however, they fail to get it because all they do is to go in there with the idea of learning something. It is a novelty to them and they fail to get right down to the real monotonous grind which trains character. Then again, in three months, they cannot get close enough to the workmen to know their viewpoint.

Most of you gentlemen are telling your students, or advising them that they had better work as a workman for a year or so at least when they go out. About one in fifty does it. They start with the idea of serving an apprenticeship, but they do not do it. Even when they go in with the best intentions, they cannot get away from this habit of absorbing, they cannot get down to the monotonous, to the tiresome work. They are not really learning anything. They feel that they have a fine college education and could do that work as well as the workman, so it does not make any difference whether they work in a shop or not. And you educators say, "Oh, yes, you should take your two years' course outside. It is up to you. Take a year or two years' apprenticeship." They don't do it, and they won't do it. They find themselves, when they are up against apprenticeship conditions in a shop, competing with young fellows of sixteen or seventeen. They cannot say, "There is not a single thing I do not know," and yet they are too old. Then, they are intellectually fastidious, while the young freshman who comes out gets next to the workmen better than the other. He is not, of course, so fastidious a man. He gets next to the workingman and learns much more than the other fellow.

About ten or twelve years ago I made up my mind not to take another young college graduate unless he has had two years' work outside, but, in going through the list, I found that there was a certain set of young men who were satisfactory right from the start. Men who had by necessity been forced to leave school and go to work. So I found that I had to modify my conclusion, by saying that I would not take a man unless he had worked outside for at least two years, or unless he had worked as a workman before he graduated. I have no other reasons why these young college men were not competent, but the facts are there. That is why we came to exclude college men who had not had actual service.

Now I want to strengthen this theory by some facts. This same investigation by Professor Furman, of the graduates of Stevens Institute, has led him to formulate at the end of the paper two sentences of the greatest importance to all teachers and to all students, as follows: "An apprenticeship of one or two years has stamped itself as the surest road to maintaining success in after life." That is his first conclusion from a study of the graduates of the Stevens Institute. A second quotation is: "A large percentage of the older graduates that now stand highest in their professional work are those who have started in as mechanical shop apprentices." That is proven by statistics, and I do not suppose Professor Furman had any more notion of those facts when he started that investigation than I or anyone else had.

One thing more, the joint committee appointed by seven of the English engineering societies, with, I think, three of the professors from universities, unanimously voted that it was desirable to have two years' apprenticeship before students graduated as engineers. I think that is a very remarkable recommendation. It goes very far toward bolstering up the theory which I have formed, that the accredited representatives of seven great engineering societies of England should recommend unanimously two years of apprenticeship before being allowed to graduate as mechanical engineers, or as any other kind of an engineer. Now, insofar as the post-graduate courses in our engineering colleges interfere with the good that the coming in touch with actual work will have, just to that extent those post-graduate courses in our colleges are bad and very much to be deplored. I do not think that the average young man needs any post-graduate course. He needs other things. He needs closer touch with actual life, and this tendency in our universities to lengthen their courses out to five or six years is a most unfortunate change. Certainly, to the average man it is a step in entirely the wrong direction.

Now, as to the liberal education, I believe that one year, conducted with a totally different kind of idea of human nature under more practical conditions, with men struggling for a living is vastly more broadening than a year of travel abroad. I am very sure that in my case the thing that impressed me was the apprenticeship, and not the travel, and I feel that it has a very liberalizing effect. If I wanted to give a boy a broad liberal view, I would get him in contact with men who are really working for a living, make him see how the other half lives. That gives him a lasting sympathy for men.

One thing more, is it possible or practicable to get this year's work for a young graduate? I feel absolutely sure it is, provided those young men are sent out to work in working conditions. If they are sent out to get an education, no. But if they are sent out and made to do a day's work, they are the finest kind of raw material. Take the average young man. He has some bad ideas, but all you have to do is to mold that young man to your needs, give him character and common sense, and when the shops begin to take these young men from our universities and colleges, particularly if it becomes a regular thing, that every year from such and such a place we can get eight or ten men, the supply will not equal the demand. Now I had great difficulty two years ago in getting one of the manufacturers to take a single college man, although he was one of the most distinguished graduates of a technical school. After trying one or two of them for a year, they now want all they can get of those men. Those men come there to do the tiresome and monotonous work, and never get any notion that they are there to learn. If they should get that notion into their heads while there, they would be stepped upon like this, "You are not here to learn anything; you are here to make money for us." Now, in point of fact, they *were* there to learn. That man lost money on them every year, but they never found that out. They are there to learn, they are studying, but they never find out that they are studying, and every time they come up with a kick, they are knocked down flat.

## Protractor Attachment for Measuring

Our attention has been called to the fact that the instrument shown in Mr. Herbert's article printed on page 271, and there stated to be of the Browne & Sharpe make, is, in fact, a product of the L. S. Starrett Company.

## Sammy's Shop—Why He Keeps Belt Records

It used to be that very few of the machines were run anywhere near steadily. The ones used were those best suited for the job at hand or if one of these was busy then some other one that was not in use would be used and the best made of it.

With things running in this way it was hard to tell how long a belt had lasted, that is, how long it had lasted in point of service as compared with a belt on some other machine. Even if compared with a belt in the same place on the same machine it was hard to make any fair comparison, for it would happen that a machine might be in great demand for some time and be seldom used at other times. It might also be doing work at times that made the belt slip while at other times the work would be very light.

As the shop got to running more nearly to its full capacity it began to appear that belts had to be replaced very often. After trying various grades of both single and double the choice got settled down to the so-called best grade of heavy single. Sammy did not chose it because he knew anything about belts that was worth knowing. He knew, of course, that a belt was made from the hide taken from some kind of a "critter," and that some of them cost a lot more than others did, and that the salesmen all sang the praises of their "high grade" belt, and told of "centered stock" and "short laps" and the superior cement used, etc., but he did not know how long a good belt should last, or how much longer it should last than each one of the other grades which cost less. He knew, from having been told it so often, that the second grade of belt which was sold by the salesman who was talking to him at the time was at least as good as the best grade of the other fellows, but when he was alone he did not know it at all.

He was trying to run a machine shop, and those of you who have had a try at the same kind of a job will know that belts were not his only troubles.

He had other troubles which kept him from thinking too much about belts, and this was a good thing for some of the belt salesmen, but when he did have to think about belts the thoughts were mostly far from pleasant.

Several times he had "blown up" the man who needed the new belt without improving matters. One man had quit, one had become so cautious that his output suffered, and one had shown that at least some of the belt had been good, for one piece had outlasted several new pieces that had been put in.

It had been the custom at one time to buy from any salesman who happened along when they were in need of belting, and that is why they had a number of different makes in use. One salesman had convinced them that it would be better to keep to one make, for he insisted that a maker would be more careful of the goods supplied to a regular customer, and for some time back only one make and one grade had been bought. Some of these belts had been, so it seemed to Sammy's judgment, not as good as they should have been, but the salesman declared that they were all of first quality and that all of the trouble came from the fact that the machines were being crowded. New "high-speed" steel was being used, and the machines were being run every day and all day and very often far into the night, and it was pointed out that belts designed to give not any too much power under the old condition of things were being overworked under the new. This seemed plausible enough and was the condition of affairs when the workman maintained that he had one piece of good belt mixed up with the bad. Fortunately this good piece had the maker's brand on it, but unfortunately that maker had gone out of business. The belt salesman, when it was put up to him, told how the belts made *now-a-days* had to be made from young hides because the people demanded young and tender meat that had been grown quickly, and therefore, very naturally the hides were also tender. Once in a while a belt maker might get hold of an oxhide or of one taken from the family cow which had been a pet and so lived long enough to be tough, but as the most of the hides had to come from the stock that had been raised for beef they were the standard, etc.

Sammy could not say that this was not all true, but when he put on a new belt one day and took it off before night and found that it resembled a snake when laid on the floor and could not be induced to lie in a straight line he thought it was time for action on his part. His first move was to see that the maker's high-grade mark was on it, and his second one was to send the belt back to the maker with it's record of service.

He then began a record. When a new belt went on the date, the length, width, grade mark, and maker's name were marked down.

The first man who came along representing a belt maker of prominence was told to send a sample belt and given to understand that if it did not give satisfaction it would be returned and if it did give satisfaction he would be given the belt orders, and would continue to get them until some bad belt was sent. When that happened it would then become a waste of time for him to call any more. Very naturally the sample belt was put in the hardest place that could be found. One of these hard places was on cone pulleys which had a short center to center distance and where the belt had to be frequently shifted from step to step. Some belts had lasted for only a few days in this place, and one that lasted for a couple of months was thought to be a good one. As long as a belt did not have to be replaced by an entire new one it was given the benefit of the record and was given credit for having lasted from the time it was put on until a new one was put on. If only a part of it was bad a new piece would be put in, and it was still counted as being the same belt. When it got to where it was not worth patching a new one would be put in and any part of the old one that was in fairly good shape was preserved for piecing out other belts.

As time went this record began to show some curious things. On one machine a belt lasted four months. The next one lasted 22 days, but the one that followed these did not have to be replaced for six years. It is needless to state that the last belt was not from the maker of the first two. On two other machines three months seemed to be the life of a belt, yet on one of them a belt lasted five years, and on the other, one lasted for three years and 11 months. These were all cone belts, and the belts that lasted the short times and those which lasted so well were used in the same places on the machines.

Looking over the record of the cone belts on the lathes it was found that one 20-inch lathe which was worked right up to its full capacity and which used to be the hardest lathe in the shop on belts had been supplied with four new cone belts in seven years and ten months. On another 20-inch lathe one belt had lasted two years and six months, while the next one had lasted three years and two months. On another 20-inch lathe the cone belt had lasted three years and one month. On a 28-inch lathe the cone belt had lasted two years and seven months. The cone belt on a 6-foot boring mill had lasted for three years and two months, and the shifting belt on a 24-inch planer had lasted for three years and six months.

The belts which lasted for such a short time always gave out by getting out of shape by stretching unevenly, one side would stretch more than the other and then the belt would begin to crowd the sides of the cones and soon it would be turning over and that would stretch it some more. Sometimes the case would get so bad that the belt would try to get up another step on the cone and pull apart. When this happened a new belt was the only remedy.

Sammy has concluded that a good belt should last on his cone pulleys from two to three years. He has not made up his mind as to how long an overhead belt should last. His records have not been kept long enough to allow him to come to any conclusion. As an estimate he thinks that they should average better than 10 years each. Even the grades of belt which did not last a reasonable time on the cones did very well on the overhead drives, and it is easy to see why this should be the case.

The overhead belt on a machine is from ½ to 1 inch wider than the cone belt. It is not subjected to the strains which come from shifting from one step to another. The pulley centers are usually greater, and the pulleys are larger than the cones in almost all cases. It can thus be seen that the overhead belt does not have the stress per inch of width that the cone belt has, and so does not have the same tendency to get out of shape.

Even if it should stretch somewhat out of shape it does not do the same amount of damage to itself that a cone belt does. Many machine-tool builders think that they have been liberal when they allow 3/16 inch more width of cone step than the belt width. And to this some of them carefully undercut the side of the step in such a way as to give the belt the greatest help in turning over, and as if this was not enough they make the face of the step part of a circle so that the belt can slide sideways easily. Where a man is making use of a machine solely for the purpose of testing the quality of belts these refinements may be all right, but where he is using it to get cut work and wants the belts to last as long as possible, they are not all right.

There is one advantage that a man generally has on his overhead belts. He can, without very great expense, change the size and width of his pulleys so as to get more belt speed and also use a wider belt. It is not very often that a belt in a machine shop is run at an economical speed.

Sammy has found that there seem to be belt salesmen who do not care to sell belts to a man who is so fussy as to keep records of the life of the belts used. Of course, with so many varying conditions entering into the matter, wrong conclusions may be arrived at, but then all men are not very accurate at guessing, either.

Sammy thinks that his records are closer approximations than his guesses would be. It may be pertinent to state that these records tell several things about the qualities of the belt makers.

## Forthcoming Meetings

American Society of Mechanical Engineers, regular monthly meeting, October 12, 8 p.m., Engineering Societies building, New York city. A paper by Prof. R. C. Carpenter, of Cornell University, upon "High Pressure Fire System of New York City."

National Machine Tool Builders' Association, fall meeting, October 12 and 13, New York City. P. E. Montanus, secretary, Springfield, Ohio.

National Society for the Promotion of Industrial Education, annual convention, December 1, 2 and 3, Milwaukee, Wis. J. C. Monaghan, secretary, 20 West Forty-fourth street, New York City.

## Business Items

The Victor R. Browning & Co., of Cleveland, O., have recently received an order for twenty-four Armington type E hoists, to go into the plant of the Pressed Steel Car Company. This is a duplicate of an order received last February.

S. E. Horton, whose father, S. E. Horton, and grandfather, Eli Horton, founded the chuck business in Windsor Locks, has started a new plant for the exclusive manufacture of lathe chucks from 6 inches to 26 inches. This new company is the S. E. Horton Machine Company and is incorporated under a Connecticut charter. Mr. Horton has had about twenty years' active experience in the chuck business and has also associated in the new company several men of special experience in chuck work. O. S. Rockwell, for about 16 years a foreman on this line of work, has charge of the new shops as superintendent. Entirely new equipment, both standard and special, has been installed and the new shops are now running on a strictly manufacturing basis.

## Business Opportunities

The Virginia (Minn.) Lumber Company will erect a new mill.

The Rockford (Ill.) Galvanizing Company is building a large plant.

A new roundhouse will be erected at Irvine, Wis., for the Soo Line.

Jonathan Lane, Houston, Texas, will remodel building to be used as garage.

S. J. Stephens, Green Bay, Wis., is to build a large addition to its cheese factory.

The Springfield Foundry Company, Pittsburg, Penn., is erecting a new foundry.

Bryan Bros., Perry, Ia., will establish a branch cement block factory in Bouton.

Sommers Bros., Saginaw, Mich., have commenced work on their new match factory.

The Tuthill Spring Company, Chicago, Ill., has bought site for an additional building.

The Atlas Brass Foundry Company, Columbus, Ohio, will erect a two-story addition.

The Star Drilling Machine Company, Akron, Ohio, is erecting an addition to its plant.

The basket and stave factory of C. C. Mumford, at Showell, Md., was destroyed by fire.

The L. & N. Railroad will erect a $45,000 roundhouse on the car-shop grounds at Paris, Tenn.

The Baltimore (Md.) Enamel and Novelty Company will build a large addition to its plant.

The Saging Threshing Machine Company, Minneapolis, Minn., will build a foundry at its plant.

The Burlington (Wis.) Brass Works will erect a new building, doubling the present capacity.

C. H. Mashland & Sons, Philadelphia, Penn., will erect an addition to their carpet factory.

The Inter-State Automobile Company, Muncie, Ind., is erecting a three-story addition to its plant.

D. W. Cooley, Waterbury, Vt., is fitting up his building to be operated as a woodworking plant.

The plant of G. P. McDougall & Son, Indianapolis, Minn., makers of kitchen cabinets, was burned.

The Wichita (Kan.) Stove and Iron Works is planning the erection of a new and larger plant.

The American Mirror Company, of Milwaukee, Wis., will erect a factory at Sheboygan, Wis.

The patent leather factory of Buckman & Kean, Woburn, Mass., was destroyed by fire. Loss, $40,000.

Fire destroyed the plant of the Tampa-Havana Lumber Company at Tampa, Fla. Loss, $100,000.

The Iowa Furniture Company, Cedar Rapids, Iowa, has completed plans for a new four-story factory.

The Draper Company, Hopedale, Mass., building textile machinery, will erect a new four-story building.

Plans are being drawn for extensions to the plant of the Pierce-Arrow Motor Car Company, Buffalo, N. Y.

The John D. Manley Implement Company, St. Louis, Mo., will erect a new plant to cost about $100,000.

The Missouri Car Company, St. Louis, Mo., will make an extension to its plant. New tools will be required.

The Buckeye Clay Pot Manufacturing Company, Toledo, Ohio, has bought site on which a plant will be erected.

The Mason City (Iowa) and Clear Lake Railway Company will commence construction of a car house at Emery.

The Corry-Deavitt-Frost Electric Company is having plans drawn for a new water-power electric plant at Berlin, Vt.

Preparations are being made to enlarge the machine shop at the United States Naval Torpedo station at Newport, R. I.

The T. A. Wilson Company, Inc., Reading, Penn., manufacturer of optical goods, is erecting a three-story addition.

The Spaulding Manufacturing Company, Grinnell, Iowa, will construct a new factory for the manufacture of vehicles.

The Chicago, South Bend & Northern Railway Company will erect a car house, repair shops, etc., at South Bend, Ind.

The Westerly (R. I.) Light and Power Company is to install another 250-horsepower generating unit in the near future.

Henderson Brothers, Waterbury, Conn., manufacturing tumbling barrels, are contemplating an addition to its factory.

The Queen City Wagon Manufacturing Company, of Lake, Miss., contemplates establishing a factory in Meridian, Miss.

The shop and forge room of the Manual Training High School, Evansville, Ind., is to be equipped with modern appliances.

The plant of the Lake Superior Lumber and Box Company, Ashland, Wis., was destroyed by fire. Loss, about $150,000.

Contracts have been let for the construction of a new roundhouse, shops, etc., at De Queen, Ark., for the Kansas City Southern railway.

The Franklin County Creamery Company, St. Albans, Vt., is to rebuild the plant recently burned and install a new ice machine.

William H. Grundy & Co., Philadelphia, Penn., operating the Bristol worsted mills, has placed contracts for a $150,000 addition.

A $200,000 cotton factory will be built at Thomasville, N. C., by John W. Cannon and J. F. Cannon, of Concord, N. C., and others.

C. T. Ford, Paris, Texas, will rebuild plant recently burned. Will install machinery for the manufacture of excelsior and felt mattresses.

The McNeil Boiler Company, Akron, Ohio, has just completed erection of two new buildings and plans are being prepared for another.

A. V. Morris & Son, Amsterdam, N. Y., is building a five-story addition to mill No. 3. The company manufactures knit goods and cap yarn.

The Fuller & Johnson Company, Madison, Wis., manufacturing agricultural implements, gasolene engines, etc., will erect an addition to its plant.

It is reported the Cameron Car Company, of Beverly, Mass., contemplates establishing a

plant in Norfolk, Va., for the manufacture of automobiles.

The Whitney Manufacturing Company, Hartford, Conn., manufacturing chains, milling machines, etc., contemplates an immediate addition to its plant.

The P. Lorillard Company, Jersey City, N. J., tobacco manufacturer, is erecting a new factory, which, it is said will be one of the largest of its kind.

The Detroit (Mich.) Wire Spring Company, which is now erecting a new factory intends building another one as soon as it is settled in the new plant.

The Conant & Donelson Company, Greenfield, Mass., manufacturing screw-cutting tools, will move to Conway, Mass., where a new plant is being erected.

The Boutwell, Milne & Varnum Company, Graniteville, Vt., is enlarging their machine shop and installing additional machinery. The company operates a quarry.

The Wichita (Kan.) Manufacturing Company, manufacturing gas and kerosene engines, is erecting a new foundry and having plans prepared for a machine shop.

The R. & D. Dick Company, of Glasgow, Scotland, manufacturing composition leather belting has bought site in Passaic, N. J., on which a branch plant will be erected.

C. W. and C. T. Shinn will locate a plant in Queenstown, Ala., for the manufacture of stoves and ranges. This is to be operated under the name of the Colonial Stove Company.

The Hydro Engine Company, of Idaho, Boise, Idaho, recently organized, is having plans prepared for a $30,000 factory. Offices are in the Boise City National Bank building.

The Bristol (Tenn.) Iron Furnace, owned by the Virginia Iron, Coal and Coke Company, is to be modernized and capacity increased. A steel-rail department will probably be handled.

The Cullman Coal and Coke Company, Cullman, Ala., will build a railroad 25 miles long from Cullman to Arkadelphia. The company has been recently organized with $2,000,000 capital.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: Oct. 12—Buffing materials (schedule 1738), brass name plates (schedule 1736), stud bolts, iron washers (schedule 1744), wood machine screws (schedule 1742), aluminum, bar steel, plate steel (schedule 1741), sheet, brass and iron (schedule 1736), iron pipe fittings, lead pipe, brass tubing (schedule 1735); Oct. 19—Gasolene engines (schedule 1754), turret machine (schedule 1752), pipe threading and cutting machine (schedule 1753); Oct. 26—Galvanized sheet steel (schedule 1745), differential, duplex blocks, breast drills, hydraulic jacks, screw jacks, planes, reamers, steel tapes, pipe vises (schedule 1746).

## New Incorporations

General Brass and Tool Works, Nashville, Tenn. Capital, $10,000. Incorporators, J. H. Lawrence, G. C. O'Bryan and C. C. Traube.

Robertson Motor Car Company, Dallas, Texas. Capital, $10,000. Incorporators, M. C. Roberts, B. M. Lindsey, Walter Lochner.

Steam Motor Company, Portland, Me., manufacturing engines, automobiles, boats, etc. Capital, $1,000,000. T. L. Croteau, Portland, president.

Texas Engine and Manufacturing Company, Houston, Texas. Capital, $50,000. Incorporators, Arthur Dubuque, D. R. Jamerson, L. A. Pitts.

Union Knife Company, Union, N. Y. Manufacture cutlery, etc. Capital, $25,000. Incorporators, C. E. Whittemore, F. E. Day, E. B. Lacey.

Western Cordage Company, Chicago, Ill. Manufacture twines, etc. Capital $250,000. Incorporators, J. H. Heldman, W. E. Rafferty, Simon LaCron.

The Indiana Auto Parts Company, Marion, Ind., manufacture automobile parts. Capital $75,000. Incorporators, G. R. Stewart, J. D. K. Kennedy, etc.

Double S. Metal Stampers, Brooklyn, N. Y. Metal stamping. Capital, $25,000. Incorporators, F. Blumenthal, I. Weissberger, W. Lamkay, New York.

Schiffenhaus Box Company, Newark, N. J., manufacture paper boxes, wood cases, etc. Capital, $25,000. Incorporators, David Schiffenhaus, K. Schiffenhaus.

Weber-Knapp Company, Jamestown, N. Y. Manufacture hardware specialties, etc. Capital, $50,000. Incorporators, A. F. Weber, E. L. Knapp, A. C. Weber.

The Veitch-Matthews Engine Company, Birmingham, Ala. Capital, $250,000. J. D. Hanby, president. George Veitch, vice-president and general manager.

Dixie Scale Company, Fayetteville, N. C. Manufacture computing scales and fixtures. Capital, $100,000. Incorporators, J. T. L. Armfield, F. H. Cotton, etc.

National Boxboard Company, Jersey City, N. J. Manufacture straw board, paper, etc. Capital, $75,000. Incorporators, S. B. Howard, S. A. Anderson, J. R. Turner.

Resilient Spring Hub Company, Newark, N. J. Manufacture hubs, wheels, etc. Capital, $125,000. Incorporators, M. Ritter, A. T. Crane, Jr., Rahway; E. R. Holmes, Newark.

The Croxton-Keeton Motor Company, 1662 Broadway, New York. Manufacture automobiles. Capital, $60,000. Incorporators, H. A. Croxton, J. P. Stoltz, W. D. Grand.

The Standish Chain Company, Kent, Ohio, manufacture chain and chain-making machine. Capital, $18,000. Incorporators, P. H. Standish, O. J. Schneider, J. B. Carey, etc.

Vacuum Car Ventilating Company, Chicago, Ill. Capital, $150,000. Manufacture vacuum ventilating machinery and appliances. Incorporators, E. B. Kittle, W. H. Gruver, Paul Brown.

Western Architectural Iron Company, Chicago, Ill. Manufacture ornamental iron, bronze and brass. Capital, $15,000. Incorporators, E. T. Noonan, W. F. Cooling, Henry Morton.

Republic Elevator and Machine Company, Rochester, N. Y. Manufacture elevators, machinery, tools. Capital, $30,000. Incorporators, F. A. Stoffel, G. H. Fagan, H. L. Morgan.

Roren Drop Forging Company, Providence, R. I. Manufacture drop forgings, tools and machinery. Capital, $100,000. Incorporators, Albert H. Roren, Wm. F. Martin, Geo. H. Raymond.

Commercial Car Company, Keyport, N. J. Manufacture motor vehicles, motor boats, engines, locomotives. Capital, $125,000. Incorporators, G. F. Smith, P. Cherry, W. Cherry, C. Russell.

The Donaldson & Fisher Company, of Chicago, Ill. Light manufacturing, tools, dies and experimental work. Capital, $100,000. Incorporators, Percy Donaldson, H. L. Fisher and others.

Automatic Compound Electric Vehicle Company, Camden, N. J. Will manufacture automobiles, etc. Capital, $100,000. Incorporators, L. E. Johnson, E. C. Waddington, Lewis Starr.

Bergen & West Side Motor Car Company, Jersey City, N. J. Manufacture automobiles, etc. Capital, $100,000. Incorporators, Chas. E. Collard, M. L. Collard, Beverly D. Sparks, all of New Egypt.

Tate Gas Electric Motor Vehicle Company, Jersey City, N. J. Manufacture motor vehicles, boats, etc. Capital, $100,000. Incorporators, John L. Tate, Charles E. Tate, John L. Tate, Jr.

Chambers Valve Company, Lyndhurst, N. J. Manufacture locomotives and car equipments. Capital, $125,000. Incorporators, J. S. Chambers, Rocky Mount, N. C.; J. C. Metzger, S. I. Leslie, Lyndhurst.

Gasolene Motor Efficiency Company, Jersey City, N. J. Manufacture steel, iron, iron and steel castings, carbureters, etc. Capital, $75,000. Incorporators, E. Leonard, Jr., F. A. Heath, H. O. Griffiths.

Saunders Car Stopper Company, Columbus, Miss., manufacture device for stopping railroad cars, etc. Capital, $250,000. Incorporators, D. R. Saunders, J. T. Wood, W. T. Folsom, Walter Weaver.

The Croxton-Keeton Motor Company, New York, manufacture automobiles. Capital, $60,000. Incorporators, H. A. Croxton, Massillon, Ohio. J. P. Stoltz, New York; W. D. Grand, East Orange, N. J.

Standard Lock Nut and Bolt Company, Jersey City, N. J. Manufacture shelf hardware, railroad, factory and founders' supplies. Capital, $500,000. Incorporators, H. O. Coughlan, L. H. Gunther, S. A. Anderson.

Leader-Beers Engineering Company, Rochester, N. Y. Manufacture engines, boilers, machinery, etc. Capital, $10,000. Incorporators, R. E. Persinger, Decatur, Ill.; Leroy Beers, Arthur Berman, Rochester.

Fraser Lock Bar Pipe Company, Jersey City, N. J. Manufacture lock bar and riveted pipe, etc. Capital, $500,000. Incorporators, John Fraser, R. T. McCormick, George P. Bard, etc. Headquarters, Room 1774, 50 Church street, New York.

## New Catalogs

Bullard Machine Tool Company, Bridgeport, Conn. Catalog describing vertical turret lathe. Illustrated, 40 pages, 8½x11 inches, paper.

The Bristol Company, Waterbury, Conn. Bulletin No. 111, describing Class II recording thermometers for feed water temperatures. Illustrated, 8 pages, 8x10½ inches.

The Garvin Machine Company, Spring and Varick streets, New York. Catalog, Edition E, printed in English, German and French, descriptive of double turret screw machines, chucking lathes, screw head shaving machines, screw machine tools and attachments, etc. Illustrated, 92 pages, 6x9 inches, paper.


# Want Advertisements

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# The Torpedo—a Machine Shop Triumph

## Its Development Has Been a Matter of Superior Mechanical Accomplishment and Its Influence a Potent Factor in Modern Warfare

BY SAMUEL ARONSON

While the world's gaze has been centered upon the advent of the flying machine—a product of mechanical ingenuity—there is another development now well known but little understood that is just as wonderful, or even more, from a purely mechanical viewpoint—the torpedo. And this development finely illustrates that what is a triumph today becomes commonplace tomorrow, and the humble old adage about familiarity is strongly recalled in the place that the torpedo has taken in the world of progress.

To many the mention of a torpedo brings to their minds a rather vague picture of a cigar-shaped shell of large proportions, internally constructed with a multitude of intricate mechanisms and contrivances hardly understandable by any others than those associated with their manufacture or operation. On the other hand, the rising generation who are so exuberant in their Fourth-of-July celebrations have the other extreme impression of a torpedo as simply a small paper bag of pebbles with a cap wrapped among them. The proverbial happy medium seems here to fit the case. From an external view the whole affair seems simplicity itself. A casual observation of the internal construction at first arouses a doubt as to the practicability of the several unique and brilliantly conceived mechanisms automatically operating and controlling the torpedo from the instant it leaves the ship on its path of destruction. Closely analyzed, however, it is seen that each theoretical idea is carried out in a practically constructed device, and the successful operation of this machine-shop triumph is sufficiently assured in the final tests that each machine must pass before it is considered ready for use.

### Early History

The history of its rather slow development is one of considerable interest. As far back as 1750 there had been recourse to stationary or movable torpedoes, but it was not until 1867 that torpedo development was brought to even a semblance of its present-day state. During our Civil War this form of destroyer became a large factor, the Confederates destroying by its use several Federal ironclads, 13 wooden war vessels and seven transports, besides damaging eight other ships more or less seriously. These damaging results were accomplished either by anchoring torpedoes in the channels, in the manner in which the "Tecumseh" was sunk at Mobile, or by exploding them alongside a vessel from a small boat. These methods, however, involved great risks, and not infrequently cost the lives of all the assailants, as happened in some of the attacks on the Union fleet off Charleston.

To supplant these clumsy methods, so dangerous to the attacking forces, a dirigible torpedo became the goal of naval inventors. An Austrian naval engineer named Lupius had spent considerable time and thought on the subject, and by 1864 had progressed far enough with his plans of an automobile torpedo to engage Robert Whitehead, then manager of an engine-manufacturing company at Fiume, Hungary, to assist in its mechanical development. From that time on Mr. Whitehead devoted himself to the automobile torpedo and succeeded in perfecting the remarkable machine which today bears his name. Whitehead's first torpedo was of a steel shell 14 inches in diameter, weighed 300 pounds, and carried as its explosive 18 pounds of dynamite. Its air chamber was made up of boiler plates and contained motive power of compressed air up to a pressure of 700 pounds per square inch, which was all the boiler plate could resist. Its speed was slow—only 6 knots an hour. From then on he made remarkable improvement in his construction, and today his torpedo is known the world over.

A few years after the Civil War Rear-Admiral Howell, of the United States Navy, went to work on the problem of torpedo development, and his efforts resulted in improvement. In considering the evolution of this remarkable form of weapon from its first crude inception to its present-day state of mechanical achievement and efficiency, the names of Simms, Harvey and Schwartzkopf, must also be mentioned, for each one's development formed a step, in one way or another, to its progress.

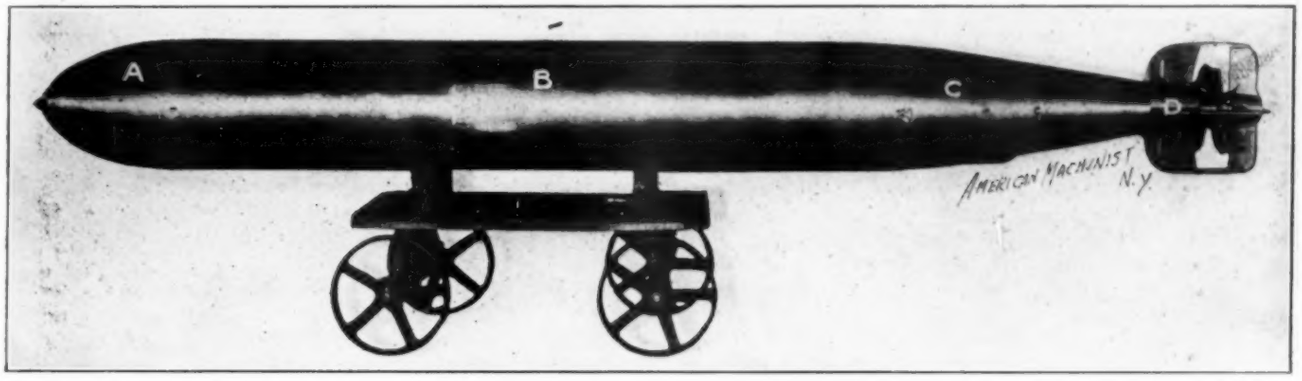


FIG. 1. COMPLETELY ASSEMBLED BLISS-LEAVITT TORPEDO DESIGNED BY FRANK M. LEAVITT AND MADE BY THE E. W. BLISS COMPANY, BROOKLYN, N. Y.

We now come to the Bliss-Leavitt type of torpedo which is looked upon by our Government as the nearest approach to perfection in torpedo construction yet produced, and it is with this type of machine that this article deals. But few can realize the amount of study and experiment that have been expended to bring about the successful development that this last-named type represents.

Incidentally the torpedo has had a wonderful influence upon the steel industry, for no sooner had the torpedo given signs of practical attainment than did the steel-makers enter upon a line of endeavor to

increase the strength and resistance of their product in which endeavor they are just as busy today as they were 40 years ago, with all the intervening improvement.

But perhaps its greatest influence has been upon the development of submarine navigation. In commenting upon this phase of its influence an eminent naval authority has said that the locomotive torpedo is undoubtedly the embryo modern submarine. The success obtained with this weapon during the last two decades has done more to solve the problems of submarine navigation than all the efforts before its introduction. But for such a masterpiece of man's ingenuity the submarine would probably be in the same condition in which Fulton left it.

### The Bliss-Leavitt Torpedo

The Bliss-Leavitt type of torpedo, the most recent arrival in the field, is 16 feet 4 inches in length, and is manufactured in two sizes, 18 and 21 inches in diameter. Complete it weighs about 2000 pounds. In the nature of the case many of the details of construction and design are unavailable for publication, but a general idea of the torpedo and how it works may be gathered from the following description and accompanying illustrations. In Fig. 1 is shown a completely assembled torpedo as it appears finished and ready for action. When the exacting requirements that each machine must meet, and the rigorous inspection it must undergo, both in the making and upon final trials, are understood, it will be realized that its design must be the result of masterful mechanical ingenuity, its production a piece of highly perfected machine-shop work, and its operation a delicate and skilful art.

The watchword in torpedo building is accuracy. And a visit to the torpedo department of the E. W. Bliss Company which has turned out more than 1000 of these destroying agents, cannot help but impress one with a deep respect for the superior methods and workmanship employed in its production. There are engaged in this department about 750 men, all of whom are mechanics thoroughly alive to the importance of their work. A single order for 300 torpedos placed by our Government is now reaching the finished state in specified time without having taxed this department's capacity for output.

In the main the torpedo is divided into four parts: The head, marked *A* in Fig. 1; the air flask *B*, the afterbody *C*, and the tail *D*. Each torpedo is supplied with two heads: one for practice and the other for actual warfare use.

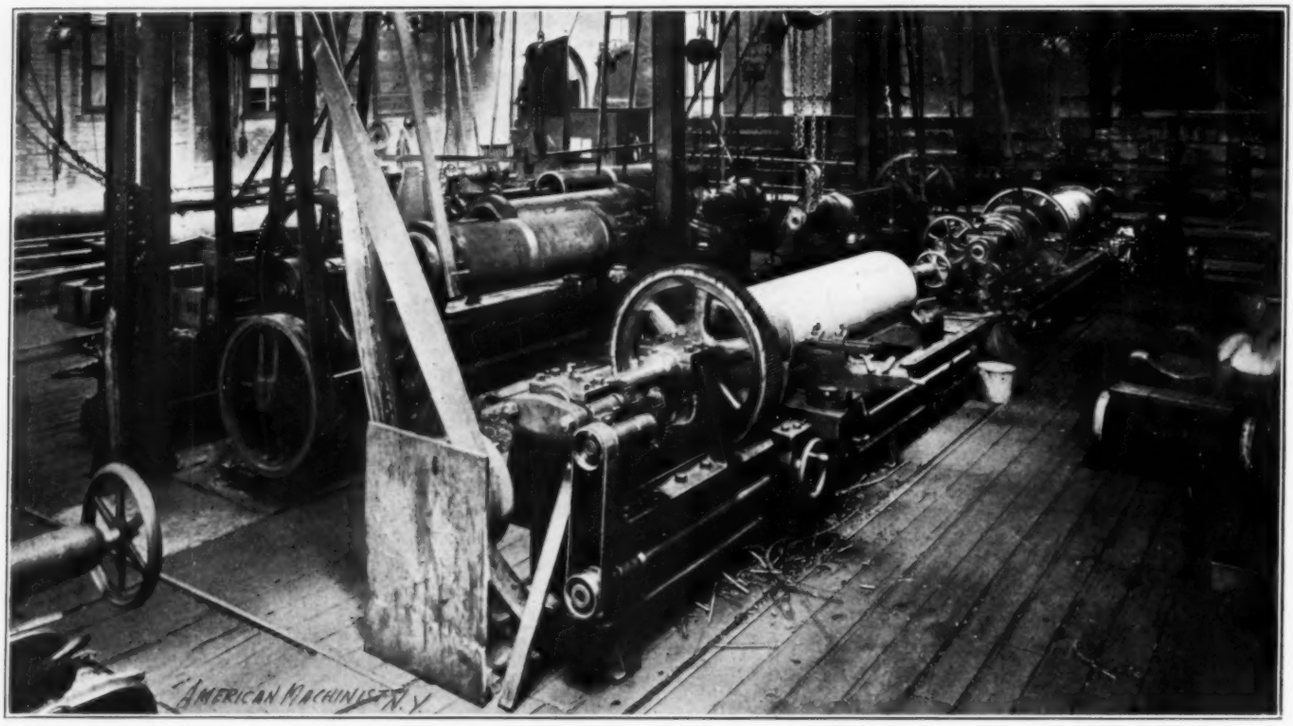


FIG. 2. LATHE OPERATIONS ON THE AIR FLASK

### The Air Flask

The air flask, as seen in the halftone, constitutes the main body of the torpedo. It is a steel forging worked from a solid ingot into shell form, and is made from a special grade of nickel steel. The shells are received at the torpedo works with walls about 1½ inches in thickness, and are machined inside and out, to a finished thickness of 7/16 inch. There are 14 lathe operations in the finishing of the flask which are necessary in order to obtain accurate balance. Fig. 2 shows two of these operations. In the rear of this halftone the flasks are shown, being rough bored on the inside, while the operation shown in the front of the picture consists of outside turning. The flasks are fitted with a head for each end, one of which is removable and the other a screw head. The removable head is thus made for the purpose of permitting cleaning out of the flask at any time. A row of the finished air flasks is shown in Fig. 3, with the midship ends plainly in view.

Each flask is divided into three compartments: a main air compartment in the center and a buoyancy chamber at each end. The forward compartment adjoining the practice head is called the buoyancy chamber, and has a connection with the main air compartment by a small valve for the purpose of draining off any water that may accumulate in the air tank. The enormous pressure at which the air is held condenses its entrained moisture and all such liquid is drawn off by means of this small valve. The rear compartment of the flask adjoining the afterbody is called the midship section, and contains the diving gear and alcohol bottle. These alcohol bottles are clearly shown in Fig. 3, and this simple apparatus constitutes one of the most recent and important advances in torpedo construction.

Before leaving the description of the air flasks it is interesting to note that they are tested in the shop under an oil pressure of 3000 pounds to the square inch, which test would surely develop any defect that might exist in the steel shell. The working pressure under which the torpedo operates when in action is 2250 pounds to the square inch, so that the shop test al-

FIG. 3. A ROW OF FINISHED AIR FLASKS

lows for a factor of safety. In this connection it might also be mentioned that the flasks are heat treated in large furnaces, as shown in Fig. 4, which treatment gives the shell the greatest possible tensile strength. This heat treatment is not given the flasks until after the many machining operations are performed on them.

### Midship Compartment

This compartment forms an 11-inch section of the main air flask, and as previously stated, contains the diving gear and alcohol bottle. Leading from the main air flask through this section is the main air pipe through which the compressed air passes. There is also a starting valve alongside of which there is a charging valve. As the torpedo leaves the launching tube a small latch that protrudes from the top of the afterbody, shown at *A* in Fig. 5, is tripped, which opens the starting valve, and thus permits the air to start the torpedo. The air then passes through a reducing valve which reduces the pressure from 2250 pounds to 450 pounds to the square inch. Thence the air passes to the superheater pot, and as the torpedo starts the alcohol in the superheater pot is ignited by a small automatically operated pistol, and the flame immediately starts superheating the air. By this means the air is brought to a temperature of about 900 degrees Fahrenheit. From the superheater pot the air passes to the turbine nozzles. The superheater pot is shown in the end view in Fig. 9, marked *A*.

The amount of work obtained from a charge of compressed air, as stored in the flask, is increased by superheating it in the manner described. The higher the temperature to which the air is heated the more power there is available, resulting both in greater range and higher speed. This superheating apparatus has been the

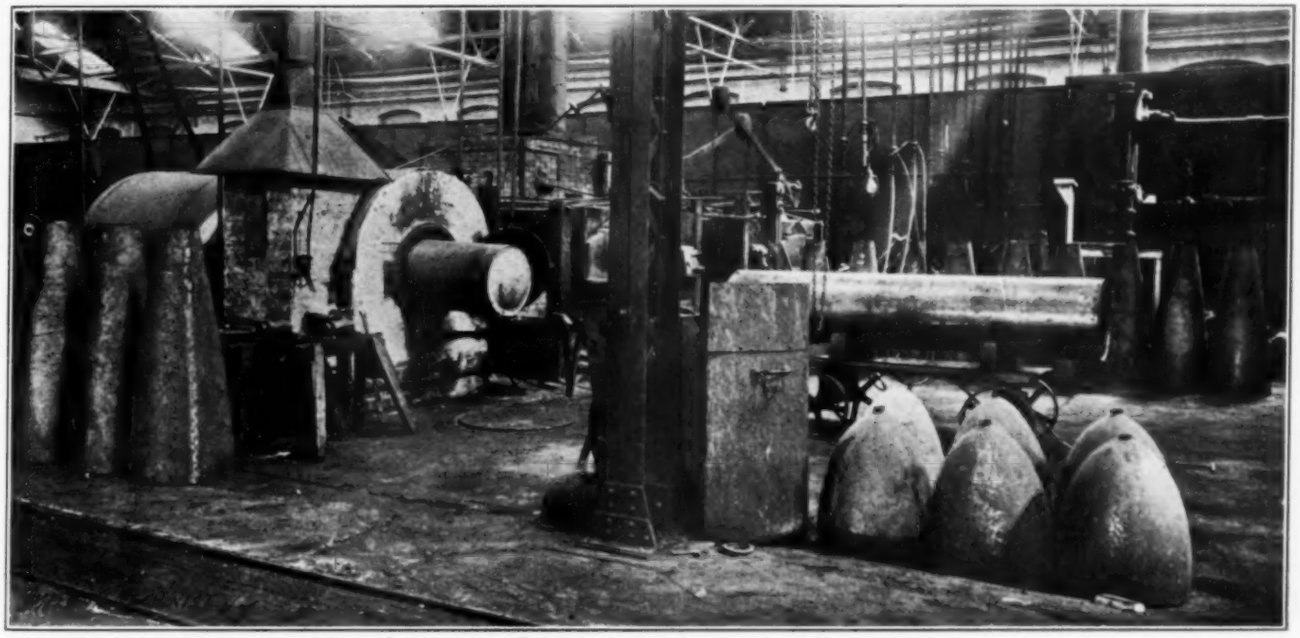

FIG. 4. HEAT TREATING THE TORPEDO PARTS

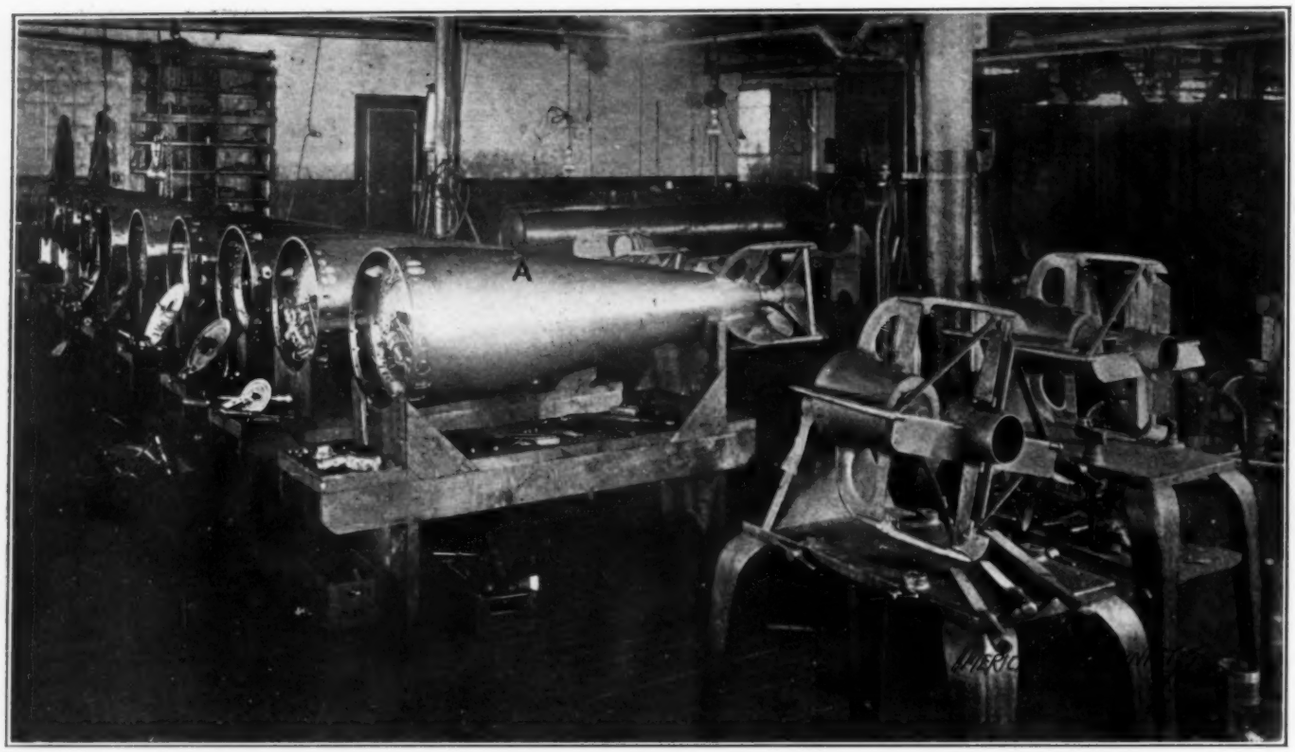


FIG. 5. AFTERBODIES READY TO HAVE ENGINE INSERTED. TAILS ARE SHOWN IN THE FOREGROUND

means of bringing the torpedo range up to 4000 yards (more than two miles), and it has also increased the speed for that range nearly 50 per cent. Another advantage that it has, too, is that it precludes the possibility of any freezing taking place due to expansion of the air through the reducing valve, or in the turbine nozzles. From the superheater the air passes to the turbine engine.

### The Turbine Engine

The characteristic feature of the Bliss-Leavitt torpedo distinguishing it from those that have gone before it is in its utilization of a turbine engine in place of the reciprocating type. A general idea of it can be obtained from Fig. 6, on the right side of which can be seen one or two of the partly assembled engines as well as the turbine wheel. The compactness of this form of engine for torpedo work can be appreciated from the engine mounted on the shaft, as shown lying on the floor in the same illustration.

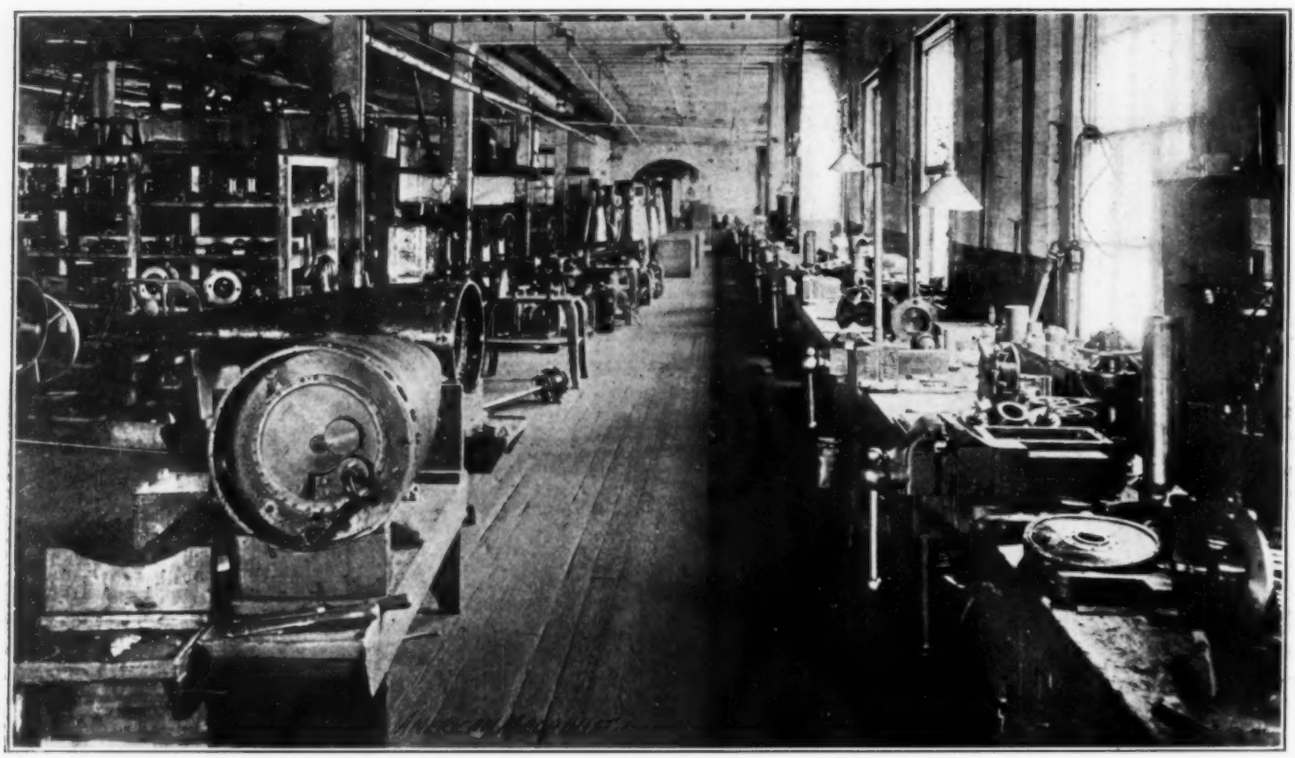

FIG. 6. FRONT CROSS VIEW OF THE AFTERBODY; TURBINE WHEEL AND ENGINES ARE SHOWN ON THE RIGHT-HAND SIDE BENCHES

The turbine is of the Curtis type, designed solely for the purpose of driving automobile torpedoes. The engine is located in the afterbody, and connected to the main shaft is an exhaust valve to which is attached a sinking gear. This sinking gear is used in war time only and is for the purpose of sinking the torpedo in case it does not strike the object at which it is fired. This sinking device, which is a very clever piece of mechanism, is simply a precautionary step so that there is no possibility of a ship coming in contact with one of its own torpedoes which may have missed and subsequently floats about in the water.

The application of a turbine engine in torpedo work is a marked advance. Its advantages are immediately apparent in that it is very compact, thus taking up but little room and allowing for more air-storage volume in a given length of torpedo. It is, of course, devoid of the more numerous parts necessary in the reciprocating type which in torpedo work are apt to require frequent adjustment. The chief advantage of this form of engine, however, lies in the fact that it is so much better able to take advantage of the superheated air, and thus brings about an increased driving power with the consequent higher speed and greater range that are very important in torpedo shooting.

It is a turbine of the balanced type, having two turbine wheels operating in opposite directions, which prevents a tendency on the part of the entire torpedo to roll in the water. The engine weighs but 45 pounds and develops as high as 125 horsepower.

FIG. 8. BENCH PRECISION LATHES ON WHICH THE GYROSCOPE PARTS ARE MADE

### The Diving Gear

As previously mentioned the diving gear is located in the midship section and its function is to keep the torpedo at a certain desired depth in the water, which is generally 6 feet. The diving gear is operated mainly by a pendulum, the action of which will bring the torpedo back to a constant level should it go up or down. The pendulum is connected to the piston of a small air engine to which are connected the horizontal rudders for controlling the depth. If the torpedo is diving too deep the pendulum, being fixed, acts on the small piston operating its air engine, which connected to the rudders, gives an up-rudder, and thus brings the torpedo to its proper level. On the other hand, if the torpedo rises too high, the pendulum and air engine have the opposite effect to bring it down to the former level. There is also an index on the diving gear so that it may be set for any depth at which it may be desired to have the torpedo travel. To be appreciated this mechanism must be seen.

### The Gyroscope

The gyroscope is the most ingeniously constructed piece of mechanism embodied in the whole torpedo and its action has been the source of constant wonder in the mech-

FIG. 7. A GROUP OF GYROSCOPES AND SPINNING WHEELS

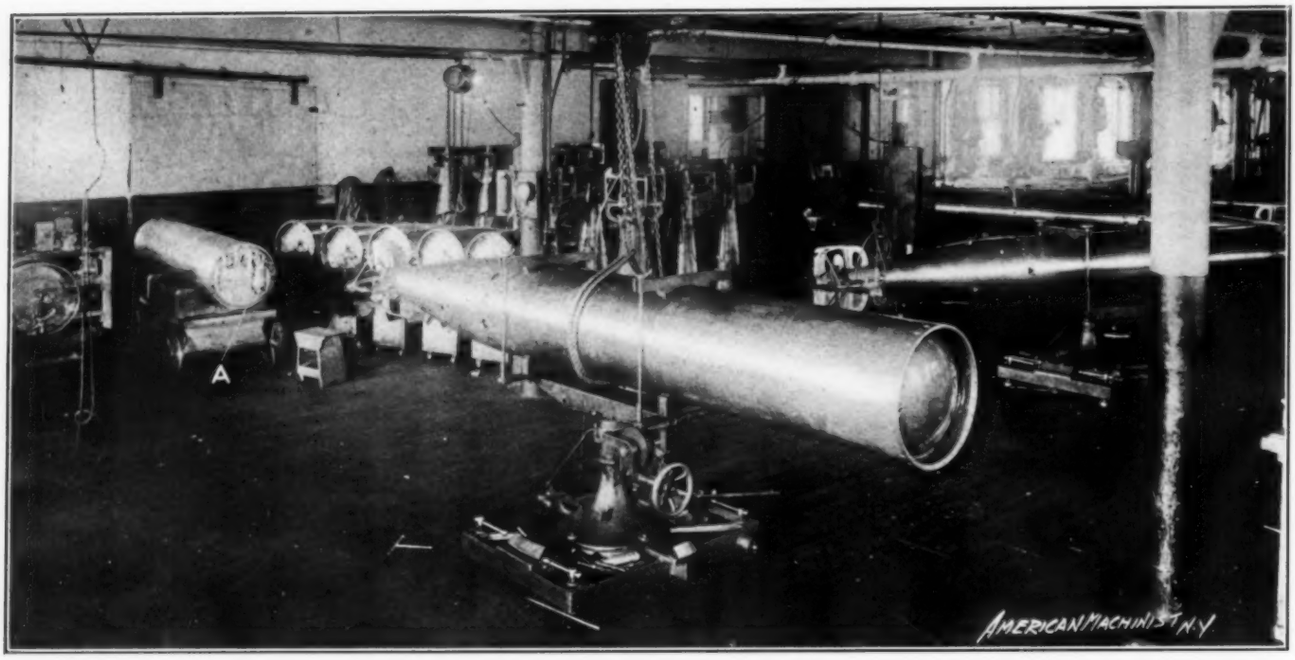


FIG. 9. TORPEDO MOUNTED ON TESTING STAND TO ASCERTAIN IF THE GYROSCOPE CONTROL IS PERFECT

anical world. The methods and workmanship employed in its construction insure the highest degree of accuracy of operation.

The gyroscope is the steering apparatus for the complete torpedo and is located in the afterbody. In its elemental form, a gyroscope is simply a flywheel so mounted in gimbal rings as to permit very rapid rotation of the wheel. Referring to Fig. 7, several completely assembled gyroscopes are shown on the forward bench, while the spinning-wheels can be seen on the upper cases. The principle on which this spinning-wheel operates is, that when once set in motion it will tend to maintain its axis in the same line regardless of external influences. Attempts to describe how and why the gyroscope acts have filled volumes of mathematics and still leave much to be explained. Briefly described its action in the control of a torpedo is as follows: The spinning-wheel, which is mounted in the gyro, is driven by a small auxiliary turbine. This small turbine is spun by a blast of air from a valve leading into the afterbody from the air chamber as the torpedo leaves the launching tube. By a small clock mechanism, the turbine wheel is drawn out of mesh with the gyro-wheel and the auxiliary turbine then automatically stops, but the spinning-wheel of the gyro continues to rotate at terrific speed due to its momentum, and becomes the controlling factor in steering the torpedo. On the top of the gyro, as can be seen in the illustration, is a small air engine which is connected to the vertical rudders by means of a rudder rod. The motion of the piston of this small air engine is transmitted to the rudders by the diverging motion of the torpedo relative to the gyro, the spinning-wheel of which maintains its axis in one fixed position. Therefore, if the torpedo should from any reason be deflected from its course, either to the right or left, the spinning-wheel, from the fact that it keeps true to its one direction, will operate the vertical rudders, bringing the torpedo back to its original course. In this way the course of a torpedo through the water becomes a series of tacks. The gyroscope thus performs the functions exactly that a pilot does in steering his vessel.

In the nature of the case the accuracy and precision with which these spinning-wheel and gyroscope parts are manufactured can be imagined. The spinning-wheels are run on ball bearings which are accurate to the 0.00025 of an inch. They revolve at about a speed of 12,000 revolutions per minute, and to give an idea as to how accurately mounted and balanced these wheels are, when once started rotating by a puff of compressed air, they will spin for 40 minutes of their own accord. The spinning-wheels as well as most of the gyro parts are made of Tobin bronze, drop forged. The gimbal rings, or cases, in which the spinning-wheels are mounted, are made of Macadamite, an aluminum composition found best suited to the purpose on account of its lightness and anti-friction qualities. These are clearly shown in the illustration, Fig. 7.

One of the latest improvements in the gyroscope controlling mechanism is that it can be so set that the torpedo can be virtually shot around a corner. That is, it may be turned in its course at any desired angle to the right or left after striking the water. This ingenious mechanism

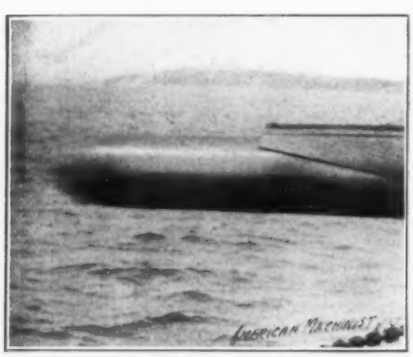


FIG. 10. LEAVING THE TUBE

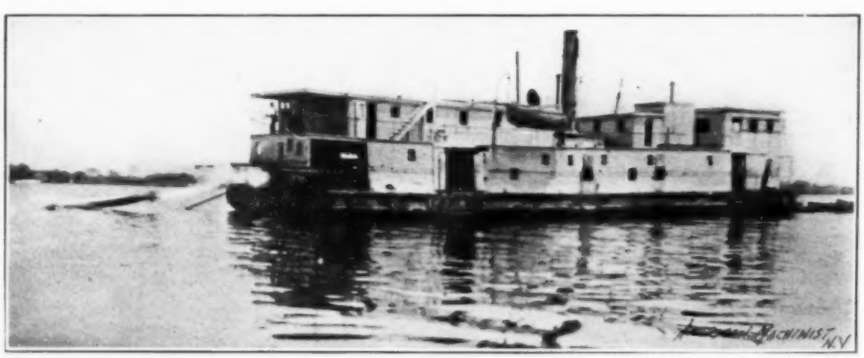


FIG. 11. ENTERING THE WATER AFTER A SHOT

was evolved through a desire to be able to shoot at any object from any position. When completely assembled each gyroscope is placed in a testing frame and operated. Every adjustment must therefore be absolutely correct before the gyroscope is placed in the afterbody.

### The Afterbody

From the foregoing it is noted that the afterbody contains the main works of the entire structure—the engine and gyroscope. It is made from sheet steel one-sixteenth of an inch in thickness. Lightness of all materials used in torpedo manufacture is essential in order to secure buoyancy. These bodies are made up in halves, pressed together and brazed longitudinally. They are annealed in the rough, as shown in Fig. 4, so as to permit easy machining.

### The Tail

Next to the afterbody comes the tail. Two of these tails mounted on machining stands are shown in the foreground of Fig. 5. The tail consists of the propellers and rudders, the propellers being driven by the main shaft of the turbine. Two propellers are used, one directly back of the other, and the tail is equipped with a reversing gear in order to drive the propellers in opposite directions. The propellers are driven in opposite directions for the same reason that the turbine wheels are; that is, to prevent a tendency of the whole torpedo to take a rolling action while on its course through the water. Each propeller is equipped with four blades, which makes for higher speed. The four large outside fins of the tail frame are designed to keep the torpedo square in the water. There are four rudders, two horizontal for depth, and two vertical for lateral steering.

### The Head

The head is made of sheet steel in halves, pressed together and brazed. The material used is of the same thickness as the afterbody. It is also annealed in the rough, as shown in Fig. 4. As previously noted, two heads are furnished with each torpedo; one the practice head, and the other the war head. The practice head is used exclusively in the shop as well as by the navy in all practice and testing work. The war heads are filled with two hundred pounds of gun cotton, and are stored in the magazines of the war vessels. An idea of what 200 pounds of gun-cotton means can be gained from the fact that if its latent energy could be utilized, it would be sufficient to lift a ton weight more than six miles in the air. In Fig. 4, the small opening in the nose of the head can be seen, in which an exploding device, or detonator, is placed. This device consists of a tiny propeller which revolves as the torpedo goes through the water, and after a certain number of revolutions sets the small hammer in a firing position. When in this position if the torpedo comes in contact with an object the hammer is permitted to strike the cap and thus ignite the explosive. Should the torpedo strike an object before the required number of revolutions of the propeller have been made, the hammer not being in the proper position cannot strike the cap, and explosion is thus prevented.

### Shop and Final Tests

In order to test the completely assembled torpedoes before they are shipped to the experiment station for final government tests, each machine is mounted on a testing stand, as shown in Fig. 9, in order to ascertain the accuracy of the gyroscope control. This is assured by deflecting the torpedo on the stand at different angles, and noting whether the rudders are turned a corresponding degree in the other direction. To determine if the engine is developing the required horsepower, the torpedo is given a trial in a large tank of water.

The final government tests are conducted at Sag Harbor, L. I., and must fulfil the following requirements: At a range of 4000 yards a buoy is set at which the torpedo is fired, and which it must strike in three successive shots. But a horizontal variation of 50 yards and a vertical variation of only 18 inches are allowed from the center of the buoy. The torpedo is shot from the tube by an impulse of compressed air. Figs. 10 and 11 show it leaving the tube and entering the water respectively. The minimum speed of 28 knots an hour must be made.

Some humanitarians are apt to view the torpedo as a fiendish invention representing civilized ingenuity savagely misdirected. Under present-day conditions, however, the opposite view seems to prevail among the leading powers of the world, which is exemplified in the belief that preparedness for war is its strongest preventative. If the latter contention is correct, then the torpedo becomes one of the greatest blessings. And the fact that its every part, from end to end, is the result of a machine-shop operation, brings to the craft large and lasting credit.

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It is said that the methods of race-track gamblers, who dope horses in order to make them win races, have been copied by unscrupulous owners of gasolene racing boats. The gasolene is doped with picric acid or some other high explosive, and with the increased power thus obtained the boats are able to win races they would lose if ordinary straight gasolene were used. On the race track there are stories of plugs which have been overdoped and died, and it is said there are also gasolene engines which have been unable to withstand an overdose of picric acid and have gone heavenward.

## Buildings for the Worcester School of Trades

By E. H. Fish*

The Worcester School of Trades building is well under way, being built from plans of Frost, Briggs & Chamberlain, of Worcester. The original appropriation was asked for on the basis of $34,000 for land, $50,000 for building and the balance of $41,000 for permanent equipment. A resurvey of the land reduced the price paid by something over $1000. Careful work put into the plans has brought about the possibility of making the $50,000 cover a building 50 per cent. larger than was originally contemplated and of greatly superior appearance.

The original plans of the commission called for a two-story shop 50x150 feet, and a four-story recitation building, 50 feet square. As the accompanying drawings show, there is now being built a shop of three floors 42x210 feet, and a recitation building, 50x57 feet, of four floors. The total floor area will be some 37,000 square feet against 25,000 under the old plan. The increase in the shop area is 65 per cent., and in the school area in the head house about 10 per cent.

The result is that instead of affording cramped shop accommodations and liberal school room for 200 day pupils, there is liberal accommodation in all ways for 300 pupils. This number of pupils is expected to be reached by admitting 30 pupils each quarter, the natural falling off of pupils as time passes being relied on to keep the total number of pupils within the limits of the school. By taking in pupils in this way it will be possible to have a comparatively small number of entirely green boys in the shop at once, and also possible to make a boy, who does not do his work up to the standard, repeat three months of his time without setting him back a discouraging distance.

### The Buildings

To get back to the building itself. The ground floor is on the level of Prescott street (the east end) and of the yard on the south side. It is three feet below the grade of Grove street. This fact has been utilized to concentrate the coat rooms, wash rooms, toilet rooms and the ventilating plant at that end of the structure. The power plant is concentrated at the east end together with the forge shop. The remaining space of 6000 square feet is left for the machine shop. Provision is made for later on installing two elevators, one for freight next the power plant with an outside loading platform and one next to the head house for passengers.

This ground-floor machine shop will have a tar-concrete floor with hemlock plank bedded in and covered with maple

*Manager of the school.

flooring. The posts are 10 feet center to center and the windows which run to the floor planking between the overhead beams are 7 feet wide with 3 feet of brickwork between. The grade of Concord street necessitates all windows on this floor being 3 feet 6 inches above the floor, but they reach so high, and the shop is so narrow, that a very light room is expected.

### Power Plant

The power plant will consist of one 54-inch by 14-foot vertical boiler, opening into a steel stack of sufficient size to take care of another similar boiler. The whole power plant is more or less of a temporary matter, as it is expected that a larger, separate plant will be built when the whole ground area is developed, possibly across Prescott street from the school. A compound engine of 60 to 80 horsepower will be installed on the level of the second floor, the space under the engine floor being reserved for pumps, etc. The power transmission will be electric, 220-volt, 3-phase, current being generated by a direct-connected generator and transmitted to motors driving groups of machines. The same kind of current can be had from the local electric-light company and used interchangeably for power purposes.

### Forge Shop

The forge shop *H*, Fig. 3, is 22x40 feet, giving sufficient room for considerable future enlargement of the shops, unless, contrary to present expectation, blacksmithing should be taught as a trade. A gas-hardening, tempering and annealing plant and sufficient forges to take care of present requirements for tool dressing, etc., will be put in at once.

On the second floor the machine shop is the same size as below. The power plant extends up through this floor and over the forge shop is a molding room *T* for the present use of boys trying out the patterns which they may have made on the floor above.

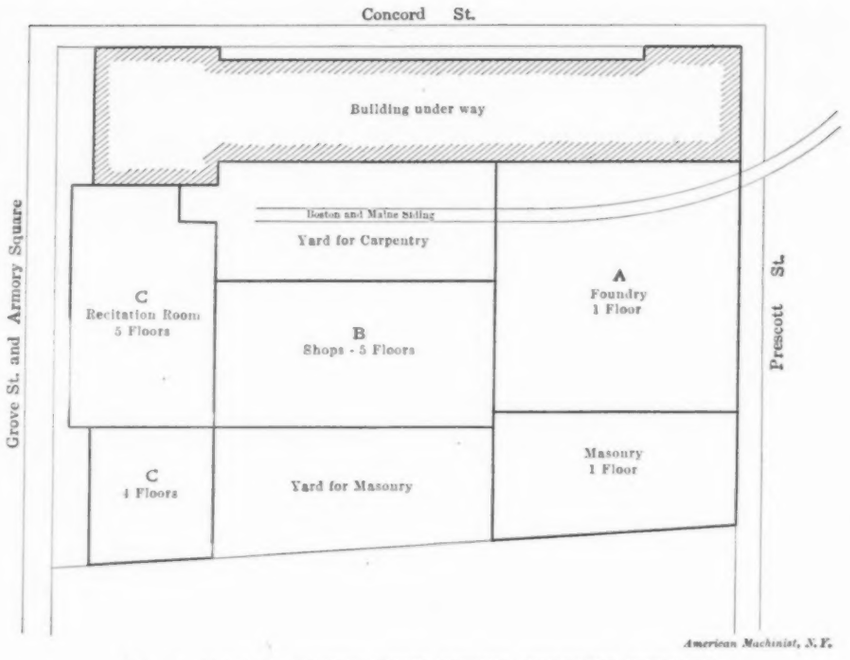



FIG. 2. PLAN OF GROUND WITH FUTURE BUILDINGS OUTLINED

### Offices

Provision is made for an office *W* for the manager and shop superintendent at the west end of this floor, and also a room *V* for student cost-keeping work. For the present, however, these officers of the school will use one of the recitation rooms for this purpose.

### Recitation Rooms

On this and the next floor above are a total of six recitation rooms *R*, all of small size, but capable of accommodating 150 boys at once. This floor also has the main entrance to the building from Grove street or Armory square, as it is called at that point. The next floor up is the top floor for the shop portion, and is left open from end to end for a wood-working shop *a*. A second wash room is provided for as the school grows on this floor. The next floor above extends only over the area of the head house. When further additions to the plant are made this floor will be cut up into three recitation rooms similar to those on the floors below, but for some time it will probably be used for a drafting room *b*, and consequently the space which on the lower floors is given over to teachers' rooms and janitor's closets is here allotted to a blueprint room *c*.

### Type of Construction of the Buildings

The construction of the building throughout is mill construction, the solid-

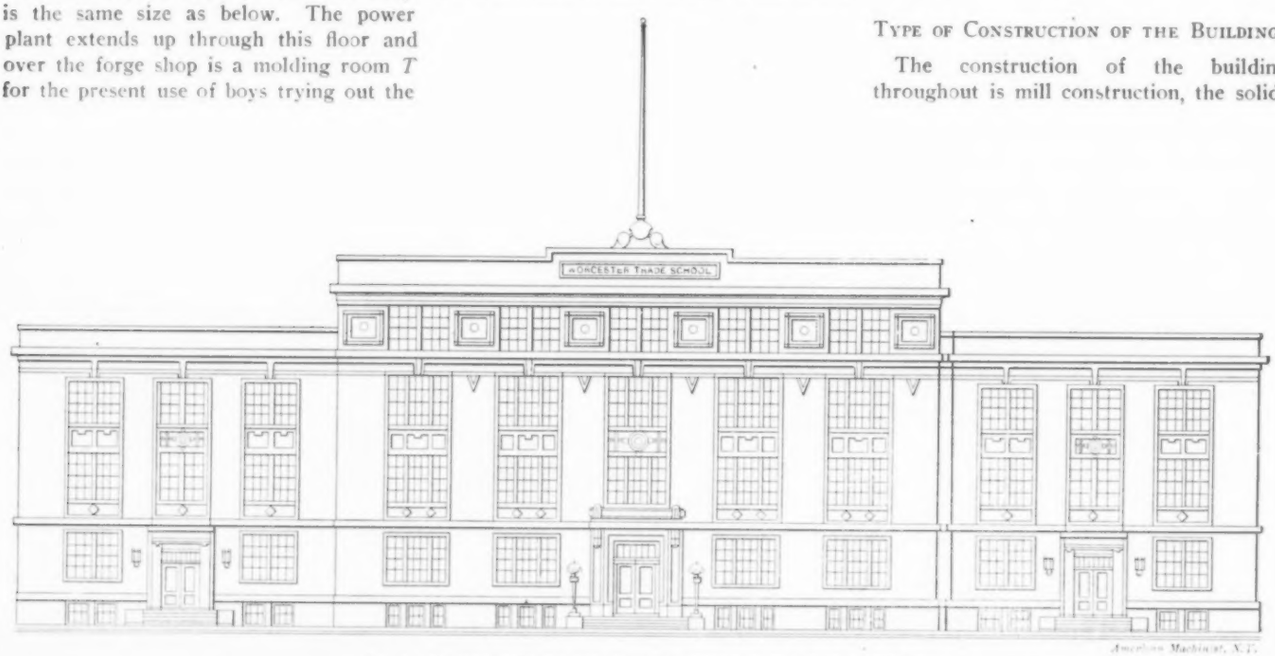



FIG. 1. ELEVATION OF BUILDING FOR WORCESTER TRADE SCHOOL

ity of which may be judged by the use of 16x16-inch hard-pine timbers for floor beams in the shop. One of the curious possibilities of building laws is illustrated in this building. The shop end, by ordinance, must carry 250 pounds per square foot floor load, and yet is allowed a 16-inch wall for the first story and 12 inches above. The head house, on the other hand, has only to carry 125 pounds per square foot, but the walls begin with 20-inch thickness and go clear to the roof 16 inches thick. This is law, not the law of nature, but the law of man. There is no plastering in the building except the little required also by law, on the ceiling of the boiler room and the warm-air rooms in the ventilating system. The remaining rooms have all brick walls, cleanly laid and to be painted white, as are also the ceilings and beams. The outside is brick with granite window sills and limestone trim.

### Plans for Future Growth

The building is only a unit in the minds of the trustees. The further development of the school has been considered and is expected to proceed according to the lines laid down in Fig. 2, where the building now being constructed is shown in shaded outline and the future buildings in clear. At *A* is a one-story building for foundry and masonry work; *B*, for more wood-working or metal-working shops and an assembly hall, and *C*, for class rooms, etc., for academic instruction. The tentative plans showed room for the teaching of some 20 of the most practical trades. There is no certainty that this original plan will be followed, but it is shown here simply to indicate that a plan for the development of the whole lot is proposed, and everything about the present school building has been planned with these future buildings in view.

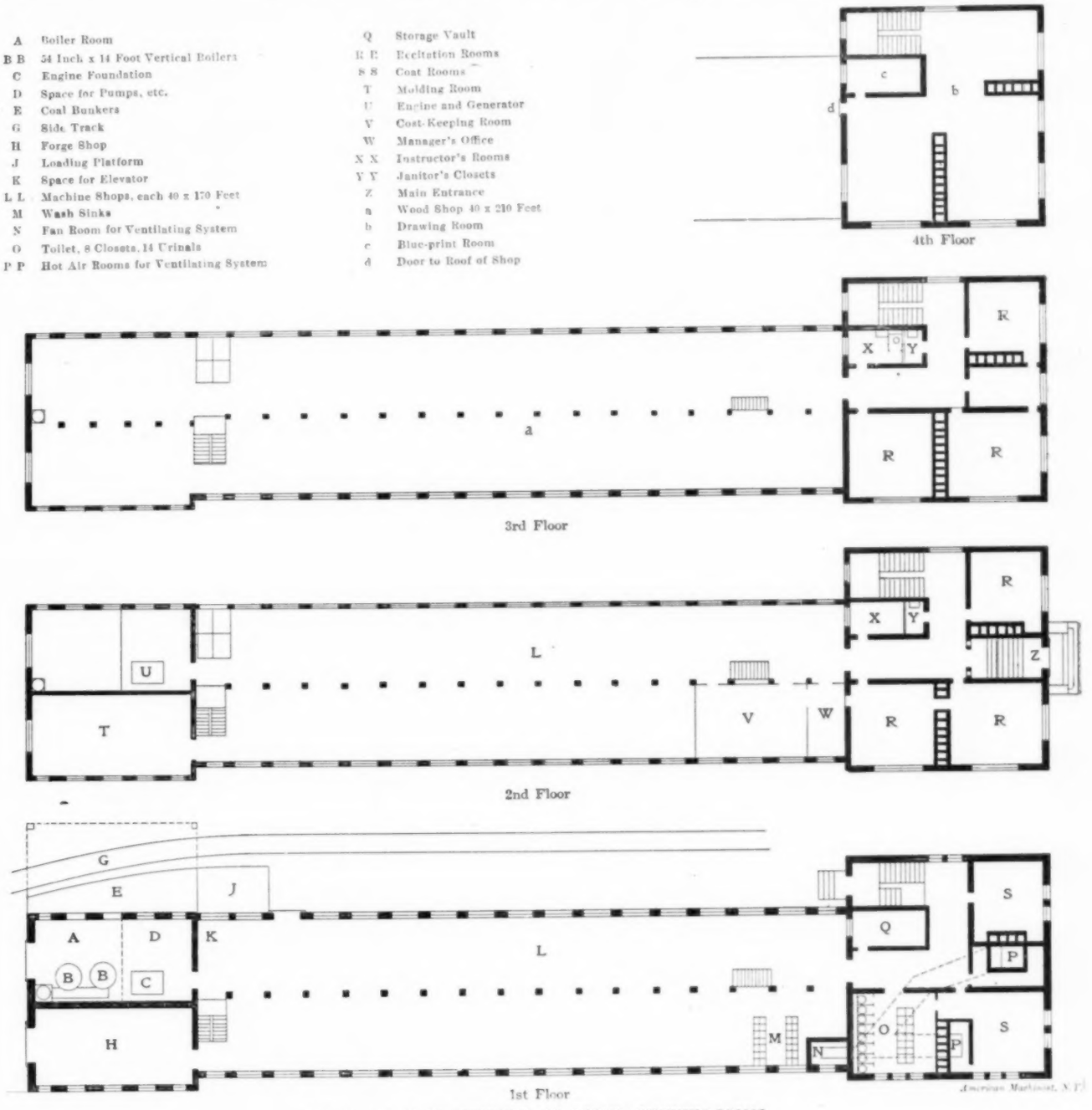

A Boiler Room
B B 54 Inch x 14 Foot Vertical Boilers
C Engine Foundation
D Space for Pumps, etc.
E Coal Bunkers
G Side Track
H Forge Shop
J Loading Platform
K Space for Elevator
L L Machine Shops, each 40 x 170 Feet
M Wash Sinks
N Fan Room for Ventilating System
O Toilet, 8 Closets, 14 Urinals
P P Hot Air Rooms for Ventilating System
Q Storage Vault
R R Recitation Rooms
S S Coat Rooms
T Molding Room
U Engine and Generator
V Cost-Keeping Room
W Manager's Office
X X Instructor's Rooms
Y Y Janitor's Closets
Z Main Entrance
a Wood Shop 40 x 210 Feet
b Drawing Room
c Blue-print Room
d Door to Roof of Shop
4th Floor
3rd Floor
2nd Floor
1st Floor

FIG. 3. PLAN OF BUILDINGS IN DETAIL, SHOWING ROOMS

### Time of Completion

The contract calls for the completion of the building about January 1. The shop portion is expected to be ready for installation of machinery nearly a month earlier.

# An Early Chapter in Machine Tool Design

We have been fortunate in securing a number of very interesting tracings, made by James Nasmyth & Co., and Joseph Whitworth & Co., in the years 1856 and 1857, to accompany machines sent to Russia at that time. These came to us through G. Beish, who secured them from Mr. Gorochoff, chief engineer of the Brianski Locomotive Company, in Biejitza, Russia, in 1905.

The first of these shows one of Nasmyth's early steam hammers and contains full directions for setting the valve gears, as well as graphic instructions as to setting up the wedges which hold the hammer head. The draftsman was also something of an artist, to judge by the position of the man swinging the ram. The steam valve was evidently operated by the connection at the top of the left-hand screw, being moved by the action of the roller *R* and cam *D* through the lever shown. The screws are solely for the purpose of adjusting the valve gear.

Fig. 2 shows what was called a double-pillar drilling machine and bears the date of January 26, 1856, the general dimensions being shown by the scale beneath. The general features of its operation are clearly shown, including the elevating table, and the fact that the whole table arm swung around the right-hand pillar,

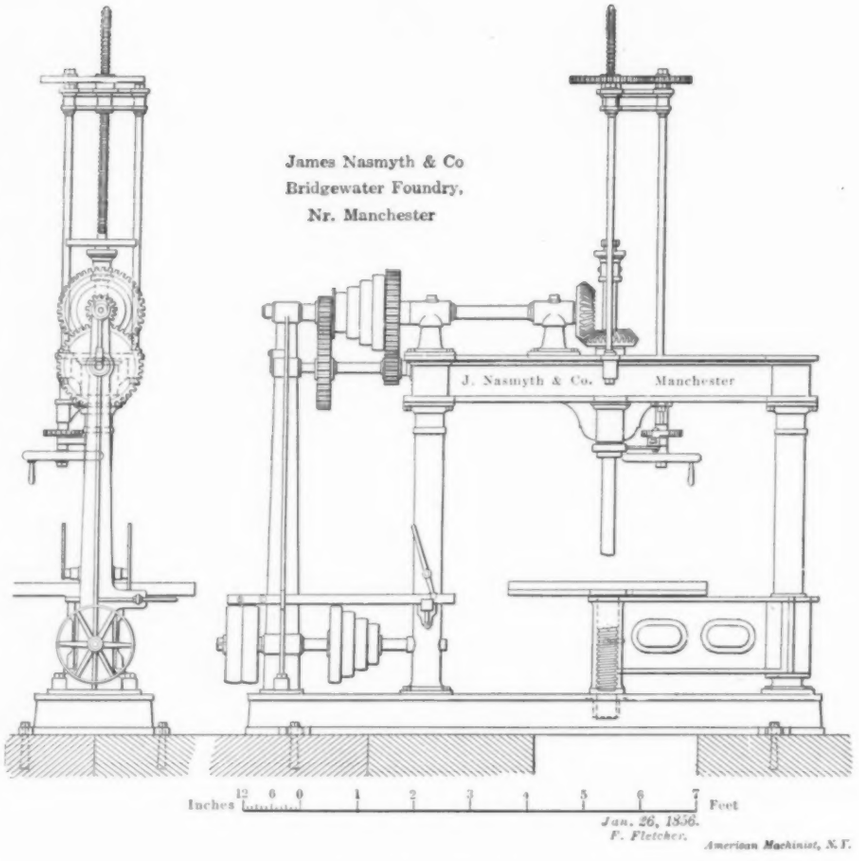

James Nasmyth & Co
Bridgewater Foundry,
Nr. Manchester
J. Nasmyth & Co. Manchester
Inches 12 6 0 1 2 3 4 5 6 7 Feet
Jan. 26, 1856.
F. Fletcher.
American Machinist, N.Y.

FIG. 2. DOUBLE-PILLAR DRILLING MACHINE.

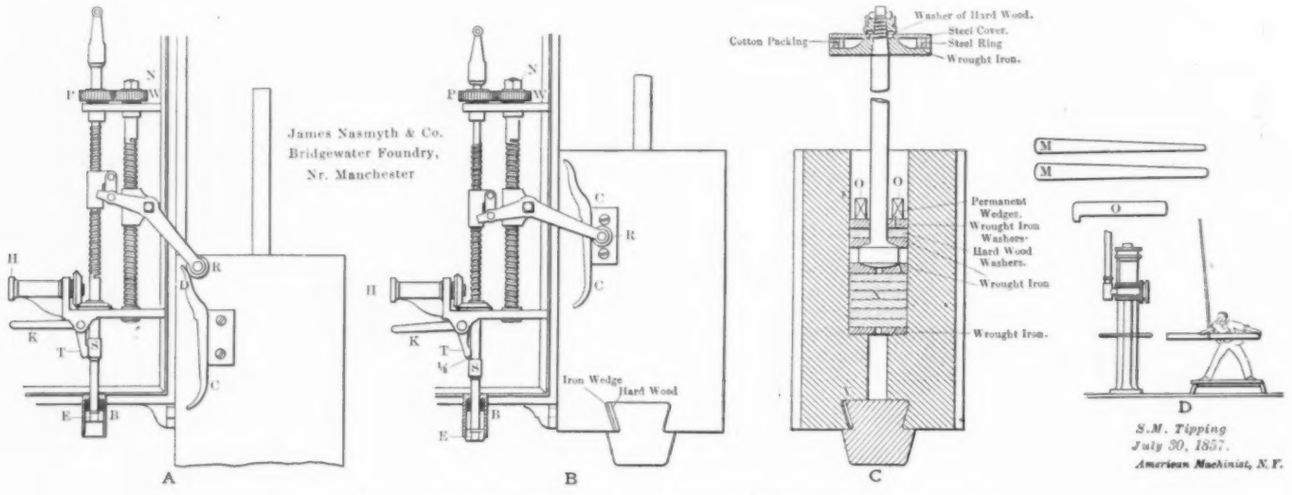



FIG. 1. ERECTION DRAWINGS OF NASMYTH'S EARLY STEAM HAMMER

In order to make the requisite adjustment of the valve gear, give most careful attention to the following remarks: When the roller *R* is in a line with the straight face of the cam *C C* the shoulder *S* should be ¼ of an inch below the point of the trigger *T*. This can be adjusted at the first by removing the nut *N* and lifting up the wheel *W*, out of gear with the other so that by turning around the handle *H* either way as may be required the roller *R* can be made to assume the right position with respect to *C C*, while *S* is ⅛ inch clear below *T*, as seen in Fig. 2. With respect to the means of regulating the other position of the roller *R*, as seen in Fig. 1, observe the following: Namely, that when the roller *R* is just entering the curve face of the cam *C O*, at *D*, so much of the leather or wood washers should be put into the buffer box *B*, that when the roller *R* is in the position with respect to *D*, as seen in Fig. 1, the nut *E* is then close up against the washers in *B*, as seen in Fig. 1. It is this which secures the just action of the valve and the smooth action of *D* on *R*. When these adjustments are effected place in gear with the wheel *P* and put on the nut *N*; then all is in proper adjustment as regards the valve and its gear. When soft blows are required, hook up the handle at *K*, so as to draw the trigger back.

*A most important point in the management of the Steam Hammer* consists in thoroughly compressing the wood packing *X*, which is placed in the well of the hammer between the wrought-iron plates *Y* and *Z*. Any want of attention to this will occasion much injury to the piston and general annoyance. In order to secure the due amount of lightness and compression so much hard-wood packing must be put between *Y* and *Z* as that when the washer *L* is laid in its place its upper edge must be so far above the edge of the key-ways as to require the use of the taper wedges *M M* to be driven in ere the washers *L* can be compressed down far enough to permit the permanent keys *O O* to be driven in after *M M*, which they displace and so retain and secure the compression effected by the wedges *M M*. The most suitable and convenient mode of driving on *M M*, as also following up with *O O*, is to sling up a heavy bar of iron to the roof and "tap" in the wedges, as shown in Fig. 4. No sledge hammer is adequate for this duty. It must be performed by a heavy bar of iron, as indicated in Fig. 4. N. B.—See that a slip of wood is used alongside of the wedge at *V*. Want of attention to this will risk the splitting of the hammer. The same observation applies to the key or wedge, which fastens in the anvil face.

making it the forerunner of the radial drill.

The small planing machine, shown in Fig. 3, has an extremely interesting drive, as the reversal and backward motions are secured without shifting or crossed belts. Power is transmitted from the belt pulley to a small pinion *A*, which drives the large wheel shown in the side view, while the chain wheel is driven from the center of this shaft, as can be seen by looking at the end. The large gear wheel is made by having studs project on the inside of the rim so as to engage the pinion teeth, and by the use of what is now known as the "mangle" gear, the pinion runs around the last stud, and its continued revolution acting from the inside of the teeth formed by these studs, reverses the motion of the large wheel and with it the planer table through the chain wheel and chain. The length of the stroke depends on the number of studs in the large wheel, which can be varied by removing or putting in as many as desired, although we would hardly consider it a convenient method at the present time. The pieces *B* and *C* act in the same way as planer dogs and throw the pinion to the inside or outside, as the case may be, and in this way reverse the motion of the table and the work. This bears the date of March 5, 1857, being drawn by the same man, as in the case of Fig. 2.

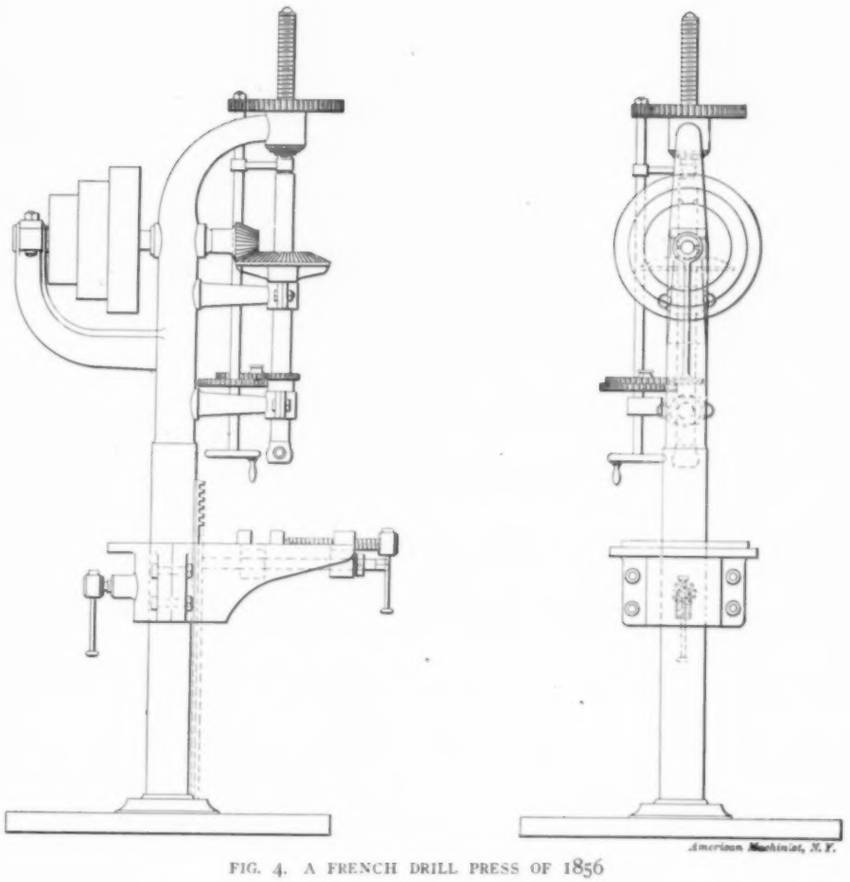


FIG. 4. A FRENCH DRILL PRESS OF 1856

In Fig. 5 is a shaper, also by Nasmyth, which is said to be still in operation. In addition to the knee or table, there seems to be a heavy projecting arbor directly under the ram for holding work, such as large hexagon nuts, the indexing being done by the worm at the back. While the flywheel is not seen in modern shapers, there are good mechanics who believe it might be used to advantage in many cases.

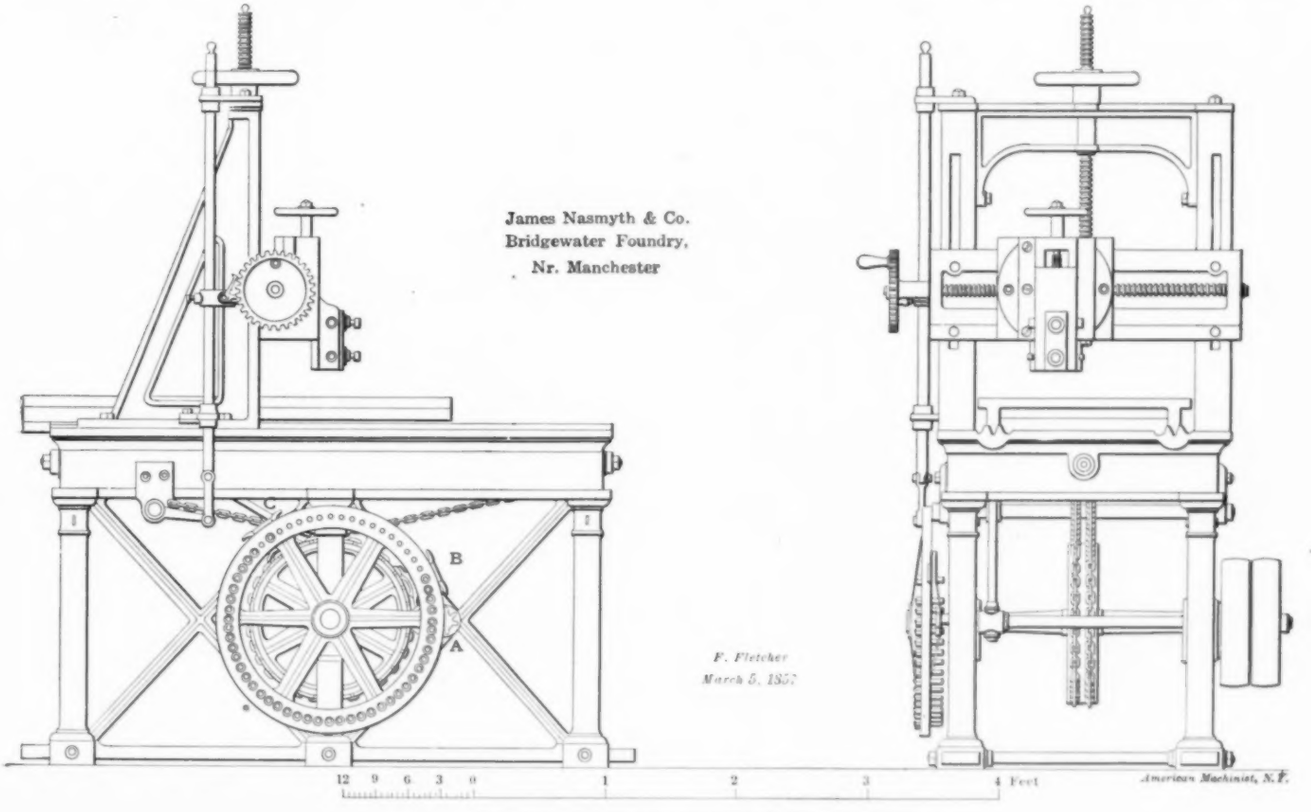



FIG. 3. SMALL PLANING MACHINE WITH NOVEL REVERSE

The worm wheel-cutting machine, shown in Fig. 7, was built by Joseph Whitworth in 1856 or 1857. It is shown hobbing a 24-inch wheel, and its construction and operation need no description. It is interesting, however, to note that a two-speed countershaft is shown, and this was a common practice of Whitworth at this time, if we judge by drawings of his lathes and other tools bearing the same dates.

The last two illustrations are French machines of the same date, Fig. 6 being a

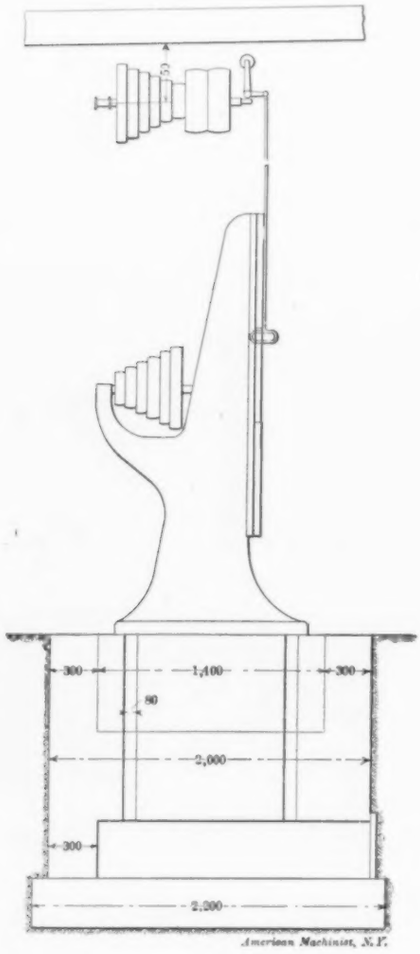



FIG. 6. FRENCH RADIAL DRILL FOUNDATIONS

foundation drawing for a radial drill, but only showing the column so as to show the foundation construction. This is particularly massive for a tool of this size, but we especially desire to call attention to the graceful curves shown in the design of the machine itself. Fig. 4 shows a French drill press by A. de Coster, which is not altogether unlike drilling machines which have been built in our own time. Perhaps the most interesting feature is the round column for allowing the work to be swung into different positions, and the elevating rack which moves around the column with the table in our modern way.

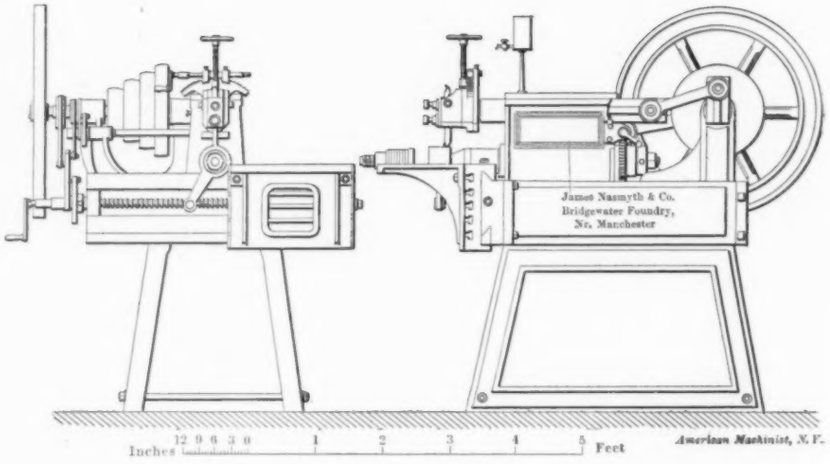
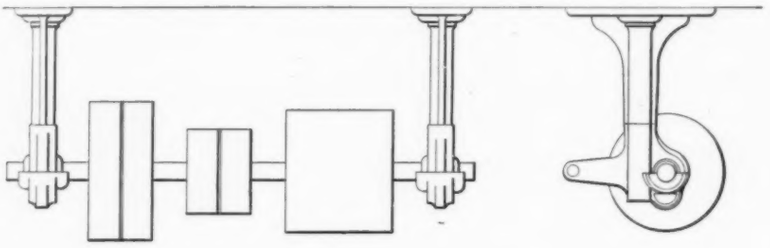



FIG. 5. AN OLD NASMYTH SHAPER



Joseph Whitworth & Co.
Manchester

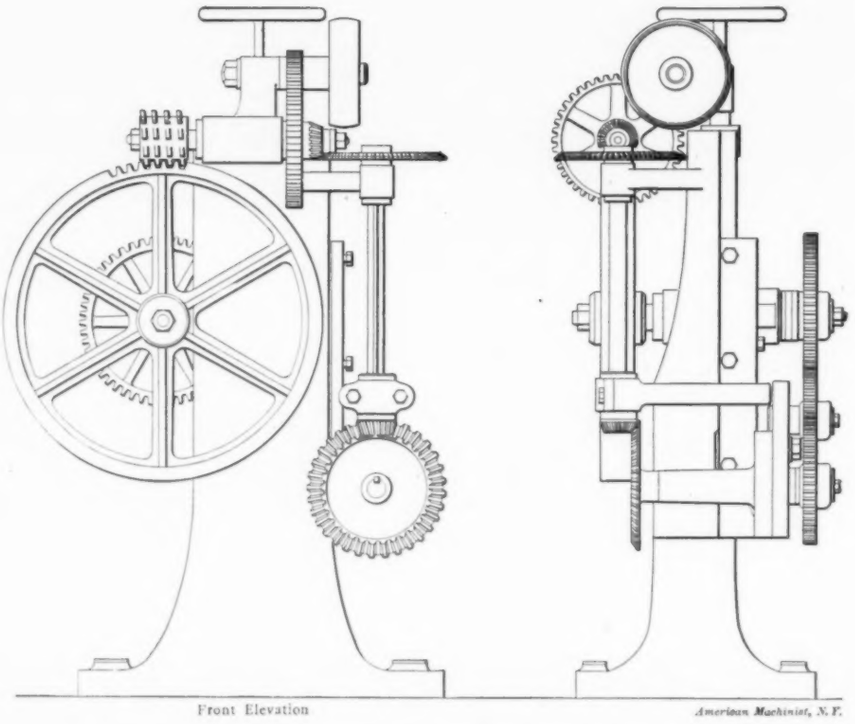



FIG. 7. WHITWORTH GEAR HOBBER WITH TWO-SPEED COUNTERSHAFT

# Building the Franklin Automobiles

## Some of the Most Interesting Tools, Fixtures and Methods Used in Building and Testing the Successful Air-cooled Car

## EDITORIAL CORRESPONDENCE

It always seemed a little peculiar, but it happens once in a while, that some one firm will take up a certain line of work and develop it into a successful business, where others have only partially succeeded or have been forced to abandon it altogether. An interesting case in point is the building of the Franklin automobile by the H. H. Franklin Manufacturing Company, Syracuse, N. Y., who have made a success of an automobile having an air-cooled engine of four or six cylinders, while this method has practically been abandoned by everyone else. That it is a success in this case is easily seen from the increased demand which will make the output for 1910 nearly 50 per cent. larger than ever before.

The cylinders are cast singly and now have vertical steel vanes or ribs on account of the new cooling system which will be shown later. The cylinders are bored under heavy drill presses of the Baker type and are finished by grinding in both Brown & Sharpe and Heald cylinder grinders.

### Machining the Engine Bases

The engine bases are of aluminum and are rather peculiar in design, as can be seen, the base for each cylinder being something of a globe and containing an individual oil pocket for the splash oiling. The first operation is the milling of the sides, as shown in Fig. 1, a double-headed plain milling machine carrying large cutters handling two of the bases at once. They are shown taking the first cut and are then rolled over so as to mill the base which carries the cylinder at exact right angles to the first face. In Fig. 2 they are being milled on the end, also in pairs, by a very similar cutter on a Kempsmith machine and are held in the very simple fixture shown. This holds them perfectly square, being alined by the flat surfaces already milled.

Fig. 3 shows the drilling jig for the side carrying the engine cylinders, all holes here being drilled at the one setting, slip bushing being used in some of the holes, as shown. The base is located solidly in the jig by the use of the hook bolts at the corners, as can be seen, and is rather an unusual method in such cases. The same jig drills all the holes in the base, as can be seen from the bushings on the nearest side, the only exception being the hole bored at magneto support which is drilled in the fixture shown in Fig. 4. These show the engine base for the model *D*, or four-cylinder cars. The fixture shown in Fig. 4 is somewhat out of the ordinary, the bushings being held in a sort of a C-clamp, which is fastened on to the engine base in the proper position, being located from the holes on the other face of the engine base.

It will be noticed in both Figs. 3 and 4 that a very convenient swinging shelf is used on these drilling machines so that all the necessary tools can be kept within easy reach and still not be in the operator's way.

### A Convenient Tapping Rig

A drilling machine has been rigged up especially for tapping holes in the engine base, as shown in Fig. 5, which shows a model *H* six-cylinder base. It is mounted on trunnions in the fixture shown, which can be adjusted to hold either four- or six-cylinder bases. This fixture is free to slide lengthwise on the base plate and this plate can be swung into any position on the supporting sector, so that by using one or both of these movements, it is possible to reach any hole to be tapped by sliding or swinging the base under the tapping. All holes that are in line can be tapped one after the other by merely pushing the supporting fixture along on its base, while by swinging the whole thing one way or the other, it is very easy to bring any desired hole under the tap.

Holes can be tapped at any angle by simply swinging the base on the trunnion of the fixture, but the carrying trunnion

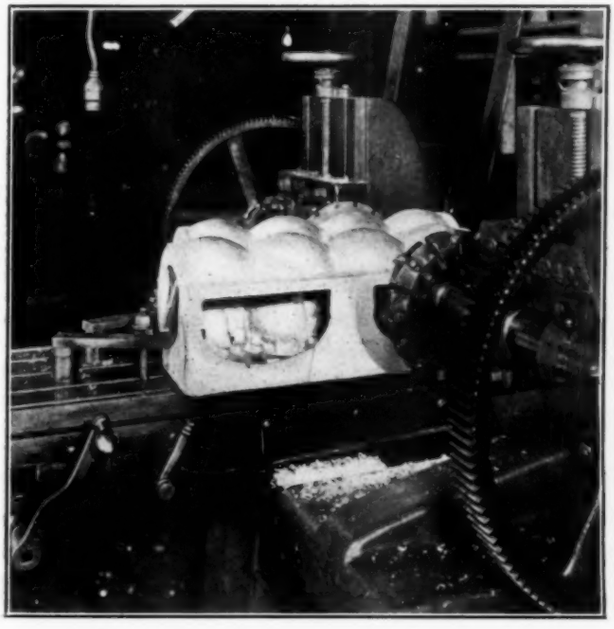


FIG. 1. MILLING TOP AND SIDE OF ENGINE BASE ON BECKER MILLER

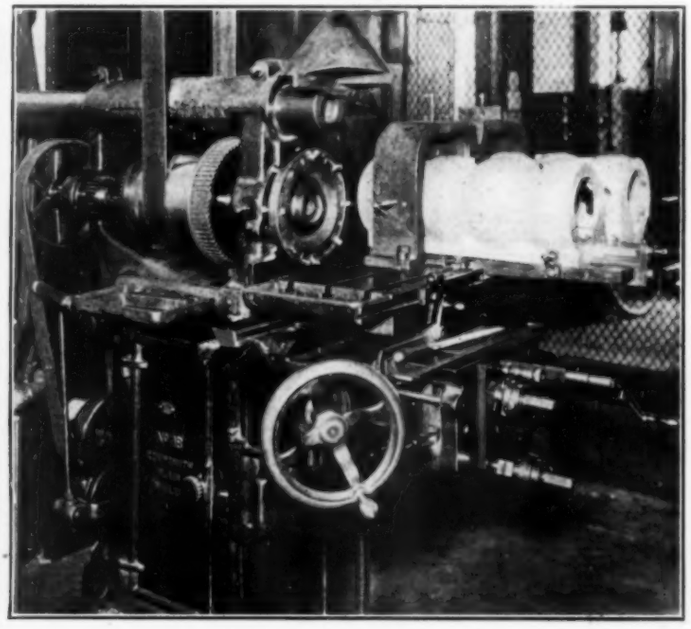


FIG. 2. MILLING ENDS OF ENGINE BASE ON KEMPSMITH MILLER

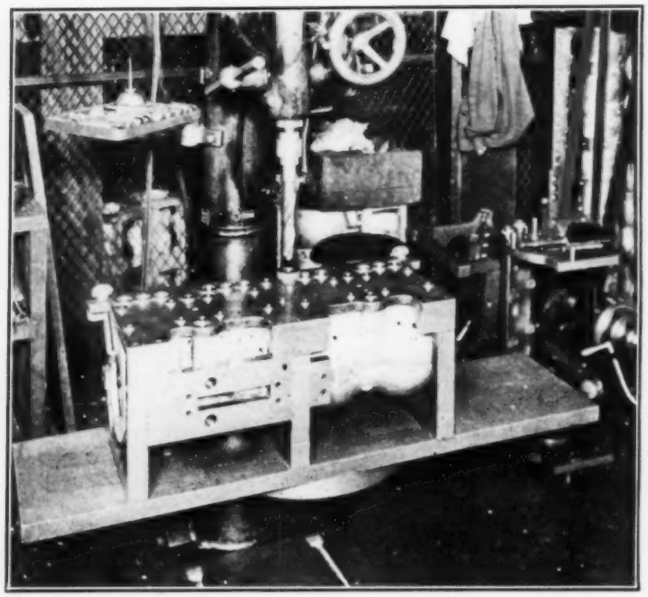


FIG. 3. DRILLING ENGINE BASE IN JIG

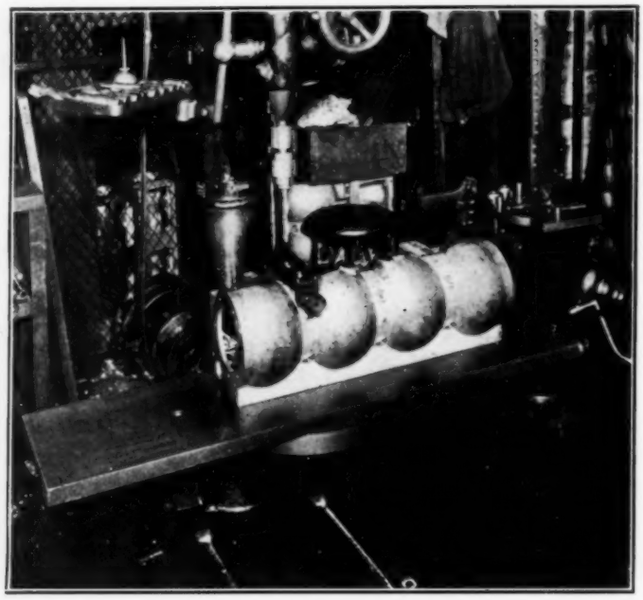


FIG. 4. DRILLING MAGNETO SUPPORT HOLE IN SPECIAL FIXTURE ON ENGINE BASE

at the farther end is indexed and held in the desired position by the latch which can be seen at the end of the engine base. The details of the tapping machine hardly need description, as it can be readily seen how the endless belt drives one pulley in one direction and the other in reverse, the smaller pulley below giving a higher speed for backing out the taps.

Another interesting drilling jig is shown in Fig. 6, in which two running-board supports can be drilled at one setting. The other side of the jig is fitted for a different-sized support. This is used under a multiple drill and can be handled very quickly. The clamps are quickly adjusted, and hold the support in place very firmly.

### Two Jobs for the Hand Milling Machine

The hand milling machine is utilized to advantage in two particular instances which are shown in Figs. 7 and 8. The first of these is the milling of key seats in the cam shaft by the aid of the special fixtures shown, which index the keyways in their proper relation to each other, place them the correct distance apart, and also firmly support the cam shaft directly under the milling cutter. The index plate locates the key seat around the shaft, while the various holes in the bed, which are fitted with hardened and ground bushings, allow the head carrying the cam shaft to be moved back into its successive positions, the different cam shafts being accommodated by the two rows of indexed holes.

There are several quite elaborate machines used in various places for rounding the ends of gear teeth used in transmission boxes of various kinds, but the simplest device we have seen is shown in Fig. 8.

This is another Whitney hand milling machine with a gear-holding fixture on the table. This indexes the gear by its own teeth and the milling cutter has a small pilot by which it is easily made to follow the outlines of the tooth. After a very little practice a boy can handle this device very rapidly indeed, and has no difficulty in rounding the ends of the teeth exactly in accordance with the tooth's shape by following it with the pilot

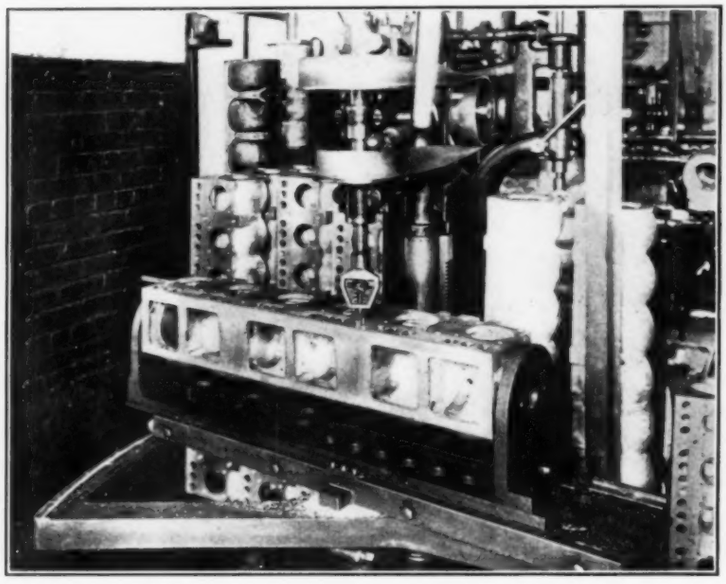


FIG. 5. TAPPING ENGINE BASE IN SPECIAL FIXTURE

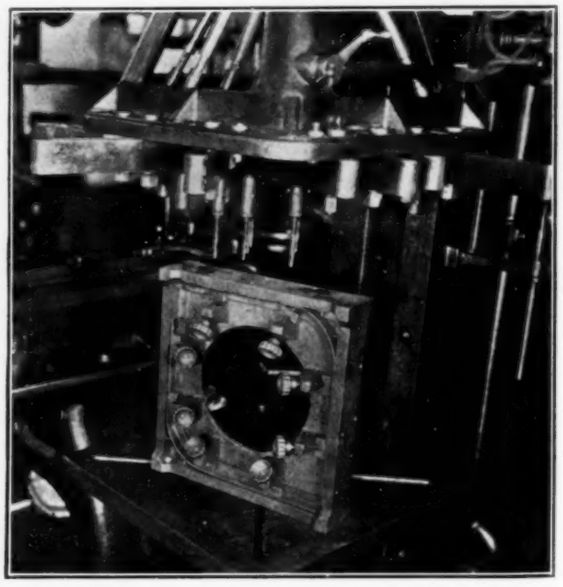


FIG. 6. DRILLING RUNNING BOARD SUPPORT IN JIG ON MULTIPLE SPINDLE DRILL

through the manipulation of both handles. This is an exceedingly simple device, and any desired curve on the ends of the teeth can be secured by making the proper cutter.

### Two Special Fixtures

An interesting boring-machine job is shown in Fig. 9, being done on a milling machine. This is the transmission-gear case, and it is very necessary that both holes be the correct distance apart, as this kind. The bars are put in place from the front, the strap across the top being easily removed for this purpose.

Backing off the teeth of the engine-clutch gear is not an easy operation as ordinarily done. Fig. 10 shows an attachment to an engine lathe which makes it comparatively easy, and can be likened to a backing-off attachment, working lengthwise of the lathe instead of across it. The lower shaft of the device is driven by the gears shown from the lathe spindle, that it is impossible to feed more than the proper depth. This makes a very neat way of backing off the clutch teeth, and the device is also used on the clutch for the starting crank.

### Pistons and Piston Rings

Fig. 11 shows a very interesting job on the Jones & Lamson flat turret with the tools used in making the piston. The turning tools are shown in their holders nearest the observer, while the tool for

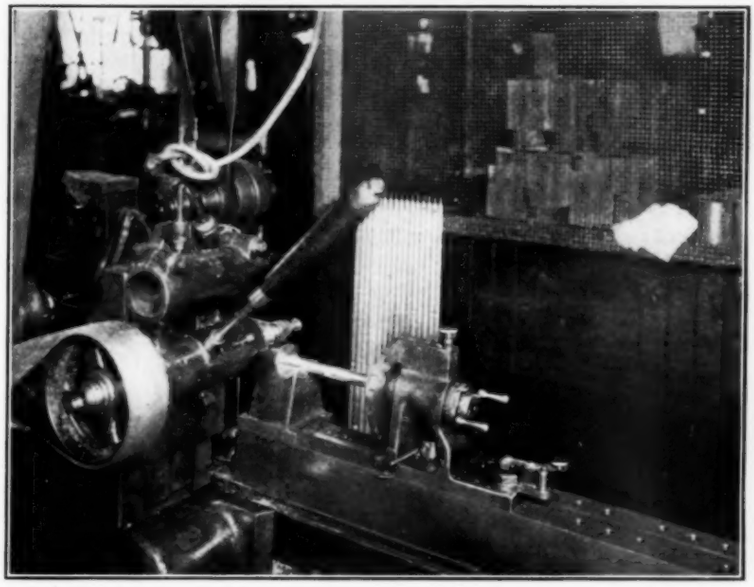


FIG. 7. CUTTING KEYSEAT IN CAM SHAFT ON HAND MILLER

FIG. 8. ROUNDING TEETH ON TRANSMISSION GEARS ON HAND MILLER

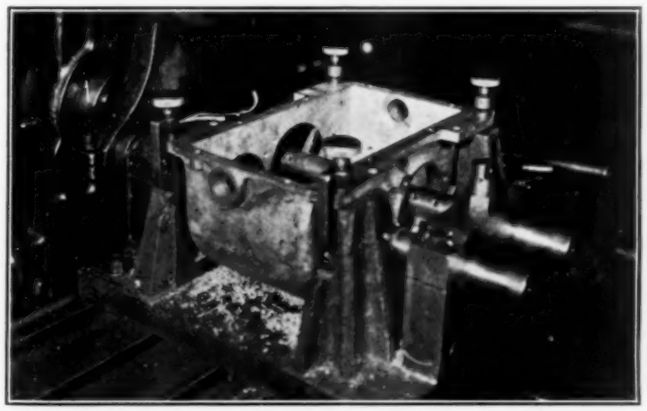


FIG. 9. BORING TRANSMISSION GEAR CASE ON MILLING MACHINE

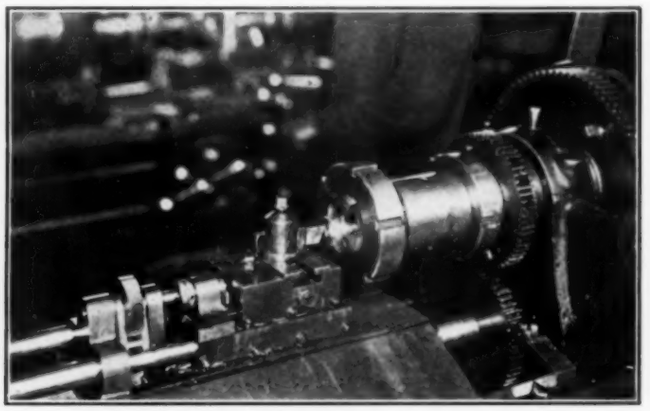


FIG. 10. BACKING-OFF ENGINE CLUTCH GEAR IN SPECIAL FIXTURE ON LATHE

well as being parallel. For this reason, both bars are held in the same fixture and are so arranged that the furthest bar is driven direct from the milling-machine spindle, and the second bar is geared to it. The driving mechanism is hung from the overhanging arm and supported by the fixture shown. The transmission case is held by the four corners on the jig upright, and is very nicely located in this way. Single-point cutters are used which seem to give the best results in work of

while the work to be done is held in the chucks shown after being properly located, so as to have the backing off occur at the right place. The cam shaft below moves the tool toward the headstock until it reaches the opening between the clutch teeth when a heavy spring carries it back to the starting point as in any backing-off attachment.

The tool is automatically fed into the work after each cut by the nurled wheel, shown on the feed screw, and is set so

facing off the end comes next in order. Following this is the holder with the five tools which cut the piston-ring grooves, and lastly a rather peculiar tool combination for sizing out the grooves by the use of standard milling cutters placed the right distance apart. These make it very easy to maintain the exact size, as by rotating the cutters slightly, new teeth are presented from time to time.

In the front of the arbor carrying these milling cutters is a center drill for center-

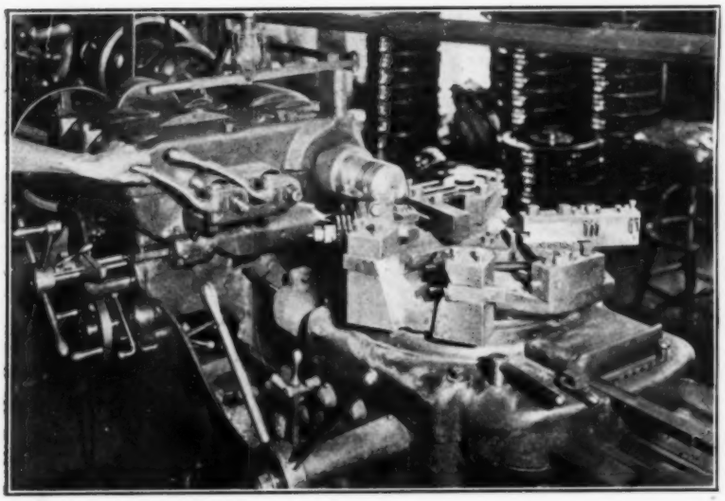


FIG. 11. TURNING PISTONS ON JONES & LAMSON TURRET LATHE

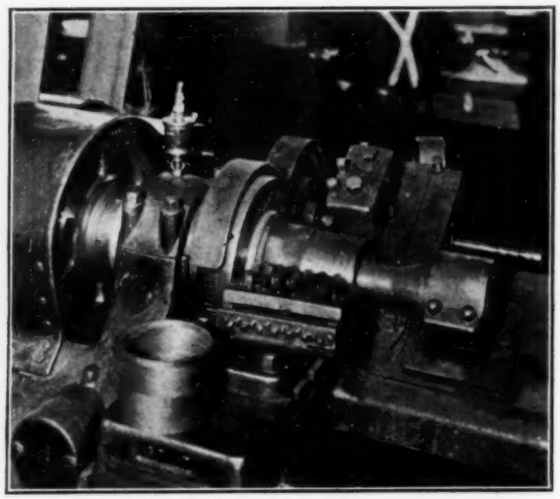


FIG. 12. TURNING ECCENTRIC PISTON RINGS ON GRIDLEY AUTOMATIC

ing the piston heads before they are removed from the chucks. As can be seen, the use of milling cutters in this way is made very easy by the cross-sliding head of this type of machine, at the same time the cutters are mounted centrally on the turret. This makes a tool layout which is somewhat unusual and all the more interesting on that account.

The piston rings are turned on a Gridley automatic shown in Fig. 12. This is a very simple machine for this work, the outside being turned eccentric with the inside if desired, as in this case, and the turning operation being followed by the gang of cutting-off tools, which begin at the outer end and drop the rings off one at a time on the supporting arm shown projecting inside the ring. The advantage of turning the eccentricity on the outside is that the cutting-off tools make an even parting, concentric with the bore, which is much better in every way when the cutting off is done on an eccentric bore unless the cutting-off tool follows the throw of this eccentric, which is unusual and not easy.

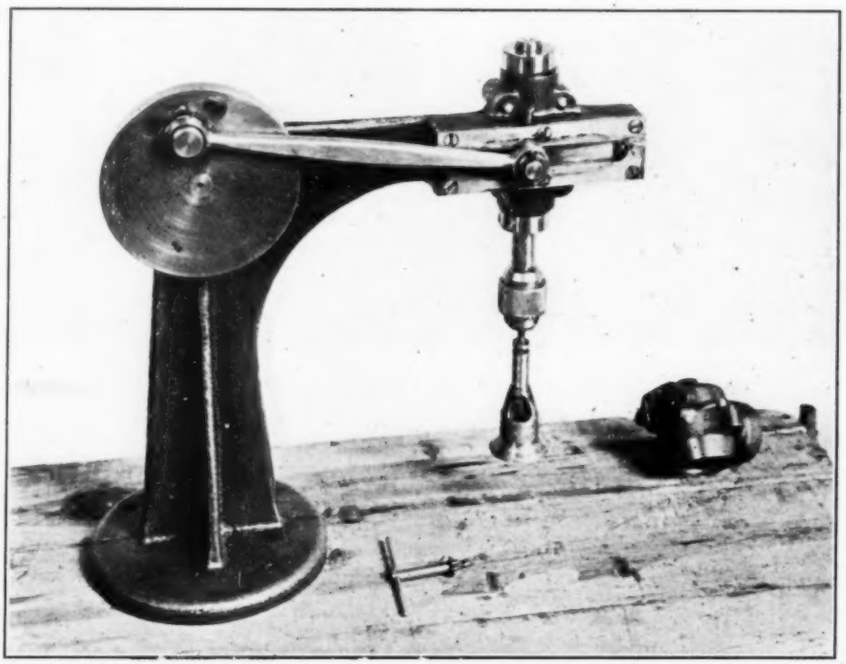


FIG. 15. VALVE GRINDING MACHINE

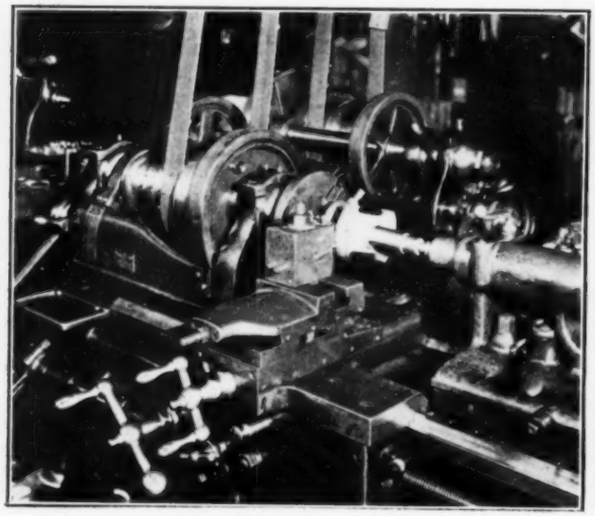


FIG. 13. TURNING INTERNAL BASE BEARING ON ENGINE LATHE

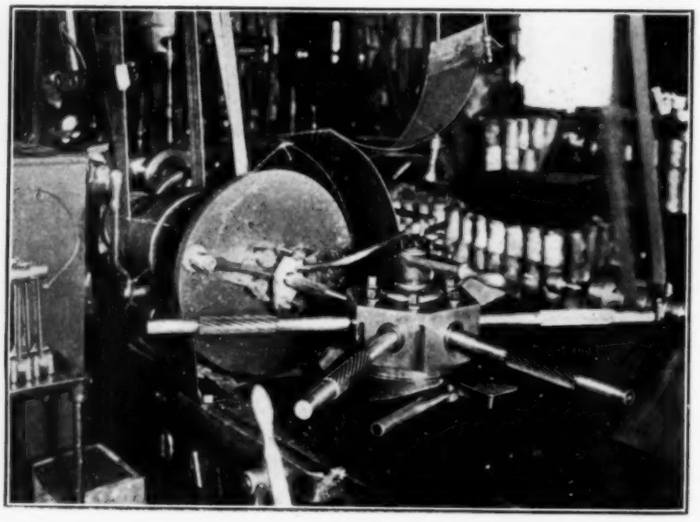


FIG. 14. SIZING BABBITT BUSHINGS IN CONNECTING RODS ON DAVIS CHUCKING MACHINE

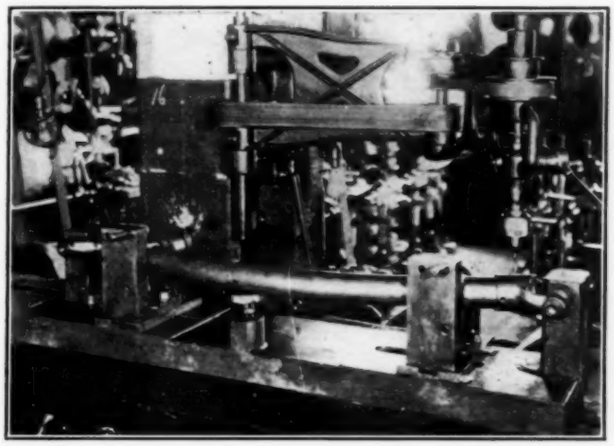


FIG. 16. ASSEMBLING FRONT AXLE

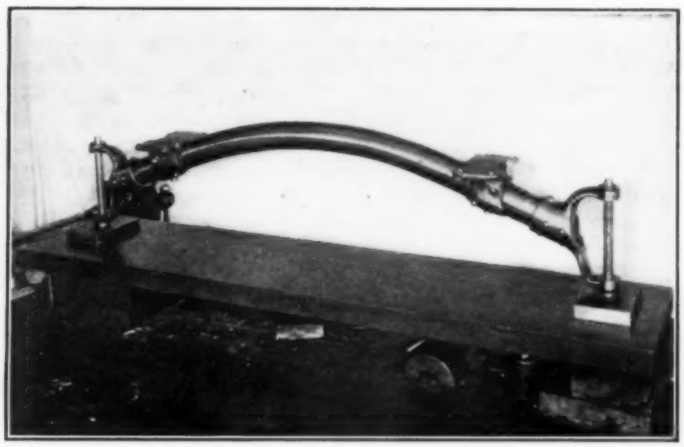


FIG. 17. LINING UP FRONT AXLE

### The Engine Bearings

It was probably noted in Fig. 5 that the interior of the engine base was bored out the same size from end to end, and that each partition between the engine cylinders carried a support for the crank-shaft bearings.

These bearings are made as shown in Fig. 13, being double-ended castings as shown, and after being bored are turned on an arbor to the size of the bore in the engine base. They are then cut in half so that the piece being turned makes two bearing supports, each half being supplied with its own cap. The tool block shown in this illustration is quite unusual, but has the advantage of being very substantial.

Fig. 14 shows a rather novel way of machining connecting-rod and other bearings. After the connecting rod has been bored and lined with its bearing metal, the cap is put in place on the end, and the whole thing mounted on the special faceplate shown on the Davis turret lathe. The center distance is located by fastening the piston end of the rod on a stud and clamping the crank end under the open-ended strap shown, which brings the bearing to be bored in its proper position.

Most of the tools shown are roughing and finishing reamers for the crank-pin bearing, and the other is what can probably best be called a burnisher. After the bearing has been roughed and finished reamed the burnisher is run through, just as though it were a reamer. This burnisher is spiral-fluted, but in the opposite direction from the reamers, and instead of having cutting edges, the lands are carefully rounded and burnished. This compresses the metal and at the same time produces a splendidly finished bearing surface. It can perhaps be likened to the practice in many railroad shops of rolling the journals on axles after being turned, and in some cases after being ground.

Valve-grinding proposition is a little different on the Franklin cylinders than on any other that we know of. In this case the two valves are concentric, and instead of being ground directly into place on the cylinder itself, they are seated in the separate casting shown with the valve-grinding machine in Fig. 15. This is simply one of the grinding heads which is to be used in connection with a number of others on a new machine that was being built at the time of my visit. It needs little explanation, the valve being held in the Jacobs chuck shown, and the grinding spindle being rotated first one way and then the other by the crank arm and slid-

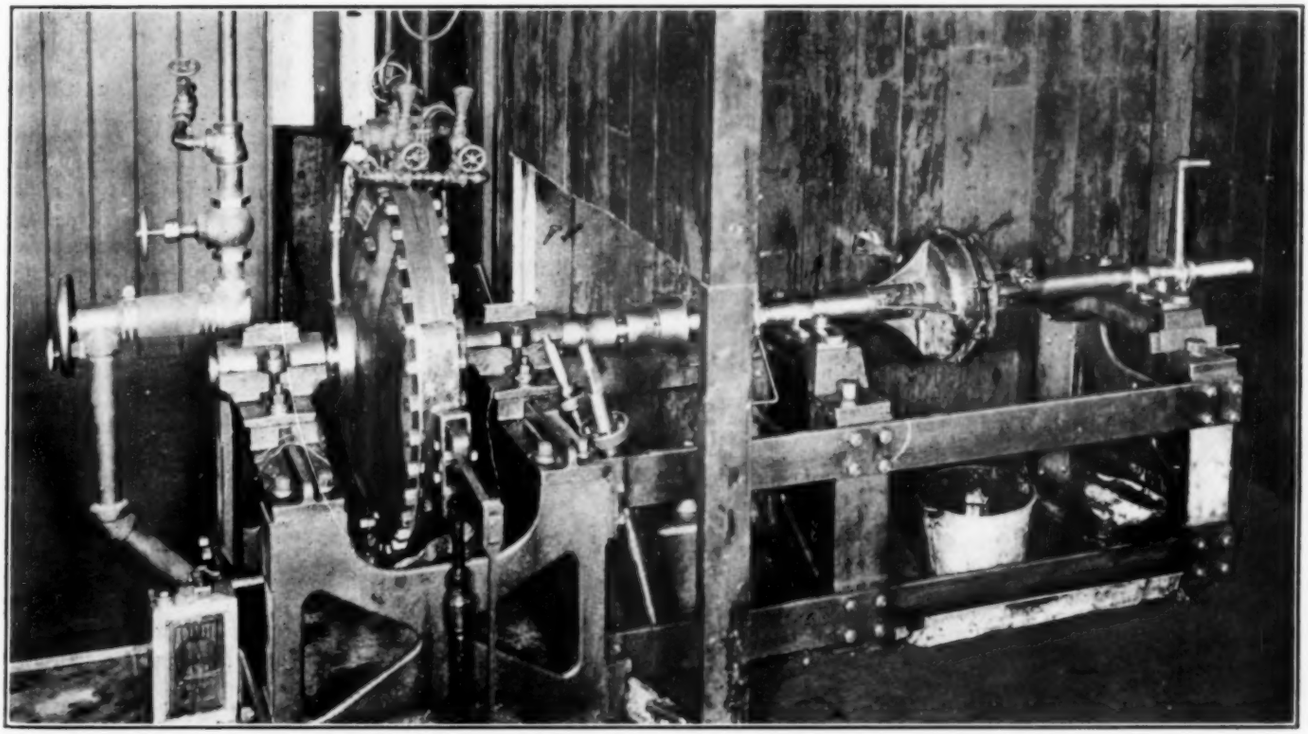


FIG. 18. TESTING REAR AXLE

ing rack shown. It makes a very simple device, and enables the work to be done very rapidly.

### Construction of the Tubular Front Axle

The Franklin car used a tubular front axle instead of the drop-forged axle of high section, and it is the belief of their engineers that this section is better able to resist all the shocks to which a front axle is subjected than the I-section. These are bent hot in a large bulldozer and are assembled with their drop-forged wheel connection and the brackets for fastening them to the wooden frame which is peculiar to this machine, in Fig. 16. The axle is supported by the jacks shown and the position of the brackets and the steering knuckles are located by the jig shown. While firmly held in this position, the holes for the rivets are drilled by the swinging arm or double radial-drill press, which is mounted on one of the columns as indicated. After having these parts riveted in place, the completed axle is lined up by the aid of the very simple gages shown. These are simply pins which fit the forks, these pins being mounted in the square bases so that in case both are not in line, one or the other will not set level on the testing plate.

### Equipment of the Testing Division

It is the aim of the engineers in this plant to have the various parts of driving mechanism tested separately, both for quiet running and to be sure they will carry their maximum load, so that when the cars are finally assembled, there will be very few chances of any of the units being imperfect in any way.

Fig. 18 shows the testing plant for the rear-axle transmission, and every rear axle takes its place on this testing plant before being assembled in the car itself. Back of the partition behind the axle shown in place, is an electric motor which drives the transmission by use of the square shaft shown projecting through the partition. Every transmission is tested at varying speed, and the power measured by the Alden absorption dynamometer, shown at the left. This dynamometer consists of friction disks which absorb the entire power, the load being accurately weighed and the disks kept cool by a free circulation of water. Any transmission which fails to run quietly at its maximum load and speed is returned to its department and is not to pass for final assembling until it runs to the entire satisfaction of the testing engineer.

After the engines are all assembled, they go to the testing room to be thoroughly tried out. All the bearings are set up snugly, so that it is difficult to turn the engines over by hand. They are then flooded with oil and coupled to an electric motor, as shown in Fig. 19, which drives them for several hours until all the bearings are limbered up into running adjustment. The covers which are shown thrown back are simply oil guards to prevent the oil being thrown out and practically represent the hood or bonnet which goes over the engine when in place on the cars.

After the engine has been thoroughly limbered up, it is taken to the testing stand in the same room, as shown in Fig. 20. Here the engine is complete and ready to be mounted on the cars. It is connected to a fan running in the large casing shown at the left, and which acts as a dynamometer for measuring the power which the engine develops. These stands have an outlet at the roof and also a side connection which is used to keep the engine cool during its test. As much of the air as may be necessary is deflected by a damper in the main pipe, and down on top of the cylinders from the elongated hood shown. It passes the air down around the cylinders, between the vertical vanes, which can be seen on the front cylinder of the first engine, and the continuous passage of the air cools the cylinders very effectively. It also keeps the testing room very cool and comfortable.

It will be noted that the upper portion of the cylinders is surrounded with a sheet-iron jacket on the outside of the vertical vanes, and this extends down to the sheet-iron deck or horizontal platform with slanting sides. At the back end of the engine's crank shaft, and forming a part of its flywheel, is a multi-bladed fan of the curved-plate type, which exhausts the air from underneath this sheet-iron deck.

When the engine is mounted in the car and covered by the hood, the exhaust fan at the back draws in a large volume of air over the deck, down between the many blades which surround each cylinder and throw it out back under the car. It insures a stream of air around each cylinder on all sides, and it is surprising what a volume of air is handled by the fan.

We are indebted to the entire staff for the opportunity presented for securing this information, and for the photographs with which it is illustrated.

F. H. C.

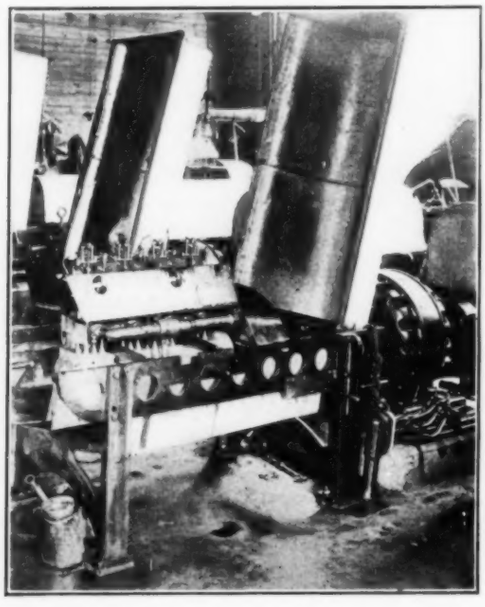


FIG. 19. MOTORING OUT ENGINES ON TEST BLOCK

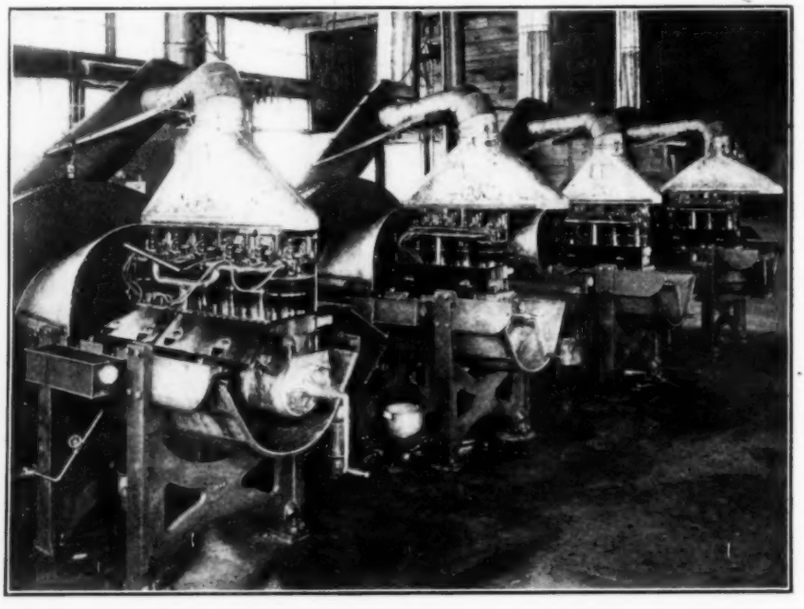


FIG. 20. ENGINE TEST UNDER OWN POWER

# Mean Effective Pressures in Air Compression or Expansion

By Frank Richards

The accompanying table and diagram, in connection with those previously given at page 360, offer special facilities for lower computations in connection with the compression or the working expansion of air. The former dealt with the interdependent ratios of pressure, volume and temperature, either of which being given, the others were readily derivable therefrom.

In the table and diagram here presented the given ratio is that of the volumes at the beginning and the end of the strokes. From that is readily determined the mean effective pressure ratio, either during the entire stroke or during compression or expansion only. On the diagram, the given ratio of volumes is read upon the base line and the required ratio of the mean effective pressure is then indicated by the vertical hight from the point thus indicated up to the curve representing the required data. It is assumed that no further explanation is required.

In computations relating to the power developed in the working expansion of air in a reciprocating engine or motor, the ratio of volumes is the particular most readily available, as that is determined by the point of cut-off, but in air compression we first know the ratio of pressures, and the ratio of volumes is derivable from this by the assistance of the previous table or diagram, so that both are necessary to constitute a complete equipment and should be kept together. Of course, only absolute pressures are dealt with, and when mean effective pressures are obtained, these also are absolute and the actual working mean effective is obtained by deducting the pressure of the atmosphere. In compound compression or expansion, there must be subtracted the total absolute back pressure, which of course must be much greater than that of the atmosphere alone.

The several columns of the table designated by capital letters, and the corresponding lines of the diagram, represent the following ratios of mean to initial, or terminal, total pressures, the given ratio in each case being the ratio of volumes.

### For Entire Stroke

*H*, Perfect gas, temperature constant.

*J*, Air expanding (or being compressed) without loss or gain of heat.

*K*, Saturated steam.

### During Expansion or Compression only

*L*, Perfect gas, temperature constant.

*M*, Air expanding (or being compressed) without loss or gain of heat.

*N*, Saturated steam.

The following are the formulas by

TABLE OF RATIOS OF MEAN EFFECTIVE PRESSURES FOR GIVEN RATIOS OF VOLUMES.

| Given Ratio. | Recip. Ratio. | H | Recip. | J | Recip. | K | Recip. | L | Recip. | M | Recip. | N | Recip. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.01 | 100 | 0.0561 | 17.825 | 0.0308 | 32.467 | 0.0500 | 20.000 | 0.0465 | 21.505 | 0.021047 | 47.619 | 0.040 | 24.752 |
| 0.02 | 50 | 0.0982 | 10.018 | 0.0591 | 16.920 | 0.0894 | 11.185 | 0.0798 | 12.531 | 0.039925 | 25.313 | 0.0708 | 14.124 |
| 0.03 | 33.33 | 0.1352 | 7.395 | 0.0860 | 11.628 | 0.1245 | 8.032 | 0.1085 | 9.217 | 0.057717 | 17.330 | 0.0974 | 10.266 |
| 0.04 | 25.00 | 0.1688 | 5.924 | 0.1171 | 8.952 | 0.1566 | 6.385 | 0.1341 | 7.457 | 0.074313 | 13.387 | 0.1203 | 8.230 |
| 0.05 | 20.00 | 0.1998 | 5.005 | 0.1365 | 7.326 | 0.1866 | 5.359 | 0.1577 | 6.334 | 0.091010 | 10.989 | 0.1438 | 6.954 |
| 0.06 | 16.667 | 0.2285 | 4.371 | 0.1604 | 6.234 | 0.2148 | 4.655 | 0.1796 | 5.567 | 0.1068 | 9.363 | 0.1647 | 6.071 |
| 0.07 | 14.286 | 0.2562 | 3.903 | 0.1836 | 5.446 | 0.2415 | 4.140 | 0.2002 | 4.995 | 0.1222 | 8.183 | 0.1844 | 5.423 |
| 0.08 | 12.50 | 0.2821 | 3.544 | 0.2061 | 4.852 | 0.2669 | 3.746 | 0.2196 | 4.553 | 0.1371 | 7.294 | 0.2032 | 4.921 |
| 0.09 | 11.111 | 0.3067 | 3.260 | 0.2280 | 4.386 | 0.2912 | 3.434 | 0.2382 | 4.198 | 0.1517 | 6.592 | 0.2211 | 4.522 |
| 0.10 | 10.00 | 0.3303 | 3.027 | 0.2493 | 4.011 | 0.3145 | 3.179 | 0.2558 | 3.909 | 0.1659 | 6.027 | 0.2383 | 4.280 |
| 0.11 | 9.09 | 0.3528 | 2.834 | 0.2701 | 3.702 | 0.3368 | 2.969 | 0.2728 | 3.665 | 0.1798 | 5.561 | 0.2548 | 3.924 |
| 0.12 | 8.333 | 0.3744 | 2.679 | 0.2903 | 3.444 | 0.3583 | 2.791 | 0.2891 | 3.459 | 0.1935 | 5.167 | 0.2708 | 3.692 |
| 0.13 | 7.692 | 0.3952 | 2.533 | 0.3100 | 3.225 | 0.3790 | 2.638 | 0.3049 | 3.279 | 0.2069 | 4.833 | 0.2862 | 3.494 |
| 0.14 | 7.143 | 0.4153 | 2.407 | 0.3293 | 3.036 | 0.3990 | 2.506 | 0.3201 | 3.124 | 0.2201 | 4.543 | 0.3012 | 3.320 |
| 0.15 | 6.667 | 0.4346 | 2.301 | 0.3481 | 2.872 | 0.4183 | 2.390 | 0.3348 | 2.986 | 0.2331 | 4.290 | 0.3157 | 3.167 |
| 0.16 | 6.25 | 0.4532 | 2.206 | 0.3665 | 2.728 | 0.4370 | 2.288 | 0.3491 | 2.864 | 0.2458 | 4.068 | 0.3298 | 3.032 |
| 0.17 | 5.882 | 0.4712 | 2.122 | 0.3845 | 2.601 | 0.4552 | 2.197 | 0.3629 | 2.755 | 0.2584 | 3.870 | 0.3436 | 2.910 |
| 0.18 | 5.556 | 0.4887 | 2.046 | 0.4020 | 2.487 | 0.4727 | 2.115 | 0.3764 | 2.656 | 0.2708 | 3.693 | 0.3570 | 2.801 |
| 0.19 | 5.263 | 0.5055 | 1.978 | 0.4192 | 2.385 | 0.4897 | 2.042 | 0.3896 | 2.567 | 0.2830 | 3.533 | 0.3700 | 2.702 |
| 0.20 | 5.00 | 0.5219 | 1.904 | 0.4360 | 2.293 | 0.5062 | 1.975 | 0.4024 | 2.485 | 0.2950 | 3.390 | 0.3828 | 2.612 |
| 0.21 | 4.762 | 0.5377 | 1.839 | 0.4524 | 2.210 | 0.5223 | 1.914 | 0.4149 | 2.410 | 0.3069 | 3.258 | 0.3953 | 2.529 |
| 0.22 | 4.545 | 0.5531 | 1.808 | 0.4685 | 2.134 | 0.5378 | 1.859 | 0.4271 | 2.341 | 0.3186 | 3.138 | 0.4075 | 2.454 |
| 0.23 | 4.348 | 0.5680 | 1.760 | 0.4842 | 2.065 | 0.5530 | 1.808 | 0.4390 | 2.277 | 0.3302 | 3.028 | 0.4194 | 2.384 |
| 0.24 | 4.167 | 0.5825 | 1.716 | 0.4996 | 2.001 | 0.5677 | 1.761 | 0.4507 | 2.217 | 0.3416 | 2.927 | 0.4312 | 2.319 |
| 0.25 | 4.00 | 0.5966 | 1.676 | 0.5147 | 1.942 | 0.5820 | 1.718 | 0.4621 | 2.164 | 0.3529 | 2.833 | 0.4426 | 2.259 |
| 0.26 | 3.846 | 0.6102 | 1.638 | 0.5295 | 1.888 | 0.5959 | 1.678 | 0.4733 | 2.112 | 0.3641 | 2.746 | 0.4539 | 2.203 |
| 0.27 | 3.704 | 0.6235 | 1.604 | 0.5439 | 1.838 | 0.6094 | 1.641 | 0.4843 | 2.066 | 0.3752 | 2.665 | 0.4650 | 2.150 |
| 0.28 | 3.571 | 0.6364 | 1.571 | 0.5580 | 1.792 | 0.6226 | 1.606 | 0.4950 | 2.020 | 0.3861 | 2.590 | 0.4759 | 2.101 |
| 0.29 | 3.448 | 0.6490 | 1.541 | 0.5718 | 1.748 | 0.6355 | 1.573 | 0.5056 | 1.977 | 0.3970 | 2.519 | 0.4866 | 2.055 |
| 0.30 | 3.333 | 0.6612 | 1.512 | 0.5854 | 1.708 | 0.6479 | 1.543 | 0.5160 | 1.938 | 0.4077 | 2.453 | 0.4971 | 2.011 |
| 0.31 | 3.226 | 0.6731 | 1.485 | 0.5986 | 1.670 | 0.6601 | 1.515 | 0.5262 | 1.900 | 0.4183 | 2.391 | 0.5074 | 1.970 |
| 0.32 | 3.125 | 0.6846 | 1.461 | 0.6116 | 1.635 | 0.6719 | 1.488 | 0.5362 | 1.865 | 0.4288 | 2.332 | 0.5176 | 1.932 |
| 0.33 | 3.03 | 0.6959 | 1.437 | 0.6243 | 1.602 | 0.6835 | 1.463 | 0.5461 | 1.831 | 0.4393 | 2.276 | 0.5276 | 1.895 |
| 0.34 | 2.941 | 0.7068 | 1.414 | 0.6367 | 1.570 | 0.6947 | 1.439 | 0.5558 | 1.799 | 0.4496 | 2.224 | 0.5374 | 1.861 |
| 0.35 | 2.857 | 0.7174 | 1.394 | 0.6489 | 1.541 | 0.7056 | 1.417 | 0.5653 | 1.768 | 0.4598 | 2.174 | 0.5471 | 1.827 |
| 0.36 | 2.778 | 0.7278 | 1.374 | 0.6608 | 1.513 | 0.7163 | 1.396 | 0.5747 | 1.737 | 0.4700 | 2.127 | 0.5567 | 1.796 |
| 0.37 | 2.703 | 0.7379 | 1.355 | 0.6724 | 1.487 | 0.7267 | 1.376 | 0.5839 | 1.712 | 0.4800 | 2.083 | 0.5662 | 1.766 |
| 0.38 | 2.632 | 0.7477 | 1.337 | 0.6838 | 1.462 | 0.7368 | 1.357 | 0.5930 | 1.686 | 0.4900 | 2.040 | 0.5755 | 1.737 |
| 0.39 | 2.564 | 0.7572 | 1.321 | 0.6949 | 1.439 | 0.7466 | 1.339 | 0.6020 | 1.661 | 0.4999 | 2.000 | 0.5846 | 1.710 |
| 0.40 | 2.50 | 0.7665 | 1.304 | 0.7058 | 1.416 | 0.7562 | 1.322 | 0.6109 | 1.636 | 0.5097 | 1.961 | 0.5937 | 1.684 |
| 0.41 | 2.439 | 0.7756 | 1.289 | 0.7165 | 1.395 | 0.7656 | 1.306 | 0.6196 | 1.613 | 0.5194 | 1.925 | 0.6026 | 1.659 |
| 0.42 | 2.381 | 0.7844 | 1.274 | 0.7269 | 1.375 | 0.7747 | 1.291 | 0.6282 | 1.592 | 0.5291 | 1.889 | 0.6115 | 1.633 |
| 0.43 | 2.326 | 0.7929 | 1.261 | 0.7370 | 1.356 | 0.7835 | 1.276 | 0.6367 | 1.570 | 0.5386 | 1.856 | 0.6202 | 1.612 |
| 0.44 | 2.273 | 0.8012 | 1.248 | 0.7470 | 1.338 | 0.7921 | 1.262 | 0.6451 | 1.550 | 0.5481 | 1.824 | 0.6287 | 1.590 |
| 0.45 | 2.222 | 0.8093 | 1.235 | 0.7567 | 1.321 | 0.8005 | 1.249 | 0.6533 | 1.530 | 0.5576 | 1.793 | 0.6373 | 1.569 |
| 0.46 | 2.174 | 0.9172 | 1.223 | 0.7662 | 1.305 | 0.8087 | 1.236 | 0.6613 | 1.510 | 0.5670 | 1.763 | 0.6457 | 1.548 |
| 0.47 | 2.128 | 0.8249 | 1.212 | 0.7754 | 1.289 | 0.8166 | 1.224 | 0.6690 | 1.493 | 0.5762 | 1.735 | 0.6540 | 1.529 |
| 0.48 | 2.083 | 0.8323 | 1.201 | 0.7845 | 1.274 | 0.8244 | 1.213 | 0.6775 | 1.476 | 0.5855 | 1.708 | 0.6622 | 1.510 |
| 0.49 | 2.041 | 0.8395 | 1.191 | 0.7933 | 1.265 | 0.8319 | 1.202 | 0.6854 | 1.459 | 0.5947 | 1.681 | 0.6703 | 1.492 |
| 0.50 | 2.00 | 0.8466 | 1.181 | 0.8019 | 1.247 | 0.8392 | 1.191 | 0.6932 | 1.442 | 0.6038 | 1.656 | 0.6784 | 1.474 |

| Given Ratio. | Recip. Ratio. | H | Recip. | J | Recip. | K | Recip. | L | Recip. | M | Recip. | N | Recip. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.51 | 1.961 | 0.8534 | 1.171 | 0.8103 | 1.234 | 0.8463 | 1.181 | 0.7008 | 1.426 | 0.6128 | 1.631 | 0.6863 | 1.457 |
| 0.52 | 1.923 | 0.8600 | 1.163 | 0.8185 | 1.222 | 0.8532 | 1.172 | 0.7084 | 1.410 | 0.6218 | 1.608 | 0.6941 | 1.441 |
| 0.53 | 1.887 | 0.8665 | 1.154 | 0.8264 | 1.210 | 0.8599 | 1.162 | 0.7159 | 1.396 | 0.6307 | 1.585 | 0.7019 | 1.424 |
| 0.54 | 1.852 | 0.8727 | 1.147 | 0.8342 | 1.191 | 0.8664 | 1.154 | 0.7234 | 1.382 | 0.6396 | 1.563 | 0.7096 | 1.409 |
| 0.55 | 1.818 | 0.8788 | 1.137 | 0.8418 | 1.188 | 0.8727 | 1.145 | 0.7307 | 1.368 | 0.6484 | 1.542 | 0.7172 | 1.394 |
| 0.56 | 1.786 | 0.8847 | 1.130 | 0.8492 | 1.177 | 0.8789 | 1.137 | 0.7380 | 1.355 | 0.6572 | 1.521 | 0.7247 | 1.379 |
| 0.57 | 1.754 | 0.8904 | 1.123 | 0.8563 | 1.167 | 0.8848 | 1.130 | 0.7451 | 1.342 | 0.6659 | 1.501 | 0.7322 | 1.365 |
| 0.58 | 1.724 | 0.8959 | 1.116 | 0.8633 | 1.158 | 0.8906 | 1.122 | 0.7522 | 1.329 | 0.6745 | 1.482 | 0.7396 | 1.352 |
| 0.59 | 1.695 | 0.9013 | 1.109 | 0.8701 | 1.149 | 0.8962 | 1.115 | 0.7593 | 1.317 | 0.6831 | 1.463 | 0.7469 | 1.338 |
| 0.60 | 1.667 | 0.9065 | 1.103 | 0.8767 | 1.140 | 0.9017 | 1.109 | 0.7662 | 1.305 | 0.6917 | 1.445 | 0.7541 | 1.326 |
| 0.61 | 1.639 | 0.9115 | 1.097 | 0.8831 | 1.130 | 0.9069 | 1.102 | 0.7731 | 1.293 | 0.7002 | 1.428 | 0.7613 | 1.313 |
| 0.62 | 1.613 | 0.9164 | 1.091 | 0.8893 | 1.124 | 0.9120 | 1.096 | 0.7800 | 1.282 | 0.7086 | 1.411 | 0.7684 | 1.301 |
| 0.63 | 1.587 | 0.9211 | 1.085 | 0.8953 | 1.116 | 0.9169 | 1.090 | 0.7867 | 1.271 | 0.7170 | 1.394 | 0.7755 | 1.289 |
| 0.64 | 1.563 | 0.9256 | 1.080 | 0.9011 | 1.109 | 0.9217 | 1.085 | 0.7934 | 1.260 | 0.7254 | 1.378 | 0.7824 | 1.278 |
| 0.65 | 1.538 | 0.9300 | 1.075 | 0.9068 | 1.102 | 0.9263 | 1.079 | 0.8000 | 1.250 | 0.7337 | 1.362 | 0.7894 | 1.266 |
| 0.66 | 1.515 | 0.9342 | 1.070 | 0.9123 | 1.096 | 0.9307 | 1.074 | 0.8066 | 1.239 | 0.7419 | 1.347 | 0.7962 | 1.256 |
| 0.67 | 1.493 | 0.9383 | 1.065 | 0.9176 | 1.089 | 0.9350 | 1.069 | 0.8131 | 1.229 | 0.7501 | 1.333 | 0.8030 | 1.245 |
| 0.68 | 1.471 | 0.9423 | 1.061 | 0.9227 | 1.083 | 0.9391 | 1.064 | 0.8196 | 1.220 | 0.7583 | 1.319 | 0.8097 | 1.235 |
| 0.69 | 1.449 | 0.9460 | 1.057 | 0.9276 | 1.078 | 0.9431 | 1.060 | 0.8259 | 1.210 | 0.7664 | 1.304 | 0.8164 | 1.224 |
| 0.70 | 1.429 | 0.9497 | 1.053 | 0.9324 | 1.072 | 0.9469 | 1.056 | 0.8322 | 1.201 | 0.7745 | 1.291 | 0.8230 | 1.215 |
| 0.71 | 1.408 | 0.9532 | 1.049 | 0.9369 | 1.067 | 0.9506 | 1.052 | 0.8385 | 1.192 | 0.7826 | 1.277 | 0.8296 | 1.205 |
| 0.72 | 1.389 | 0.9565 | 1.045 | 0.9414 | 1.062 | 0.9541 | 1.048 | 0.8447 | 1.183 | 0.7906 | 1.265 | 0.8361 | 1.196 |
| 0.73 | 1.370 | 0.9597 | 1.042 | 0.9456 | 1.057 | 0.9575 | 1.044 | 0.8509 | 1.175 | 0.7985 | 1.252 | 0.8426 | 1.186 |
| 0.74 | 1.351 | 0.9628 | 1.038 | 0.9497 | 1.053 | 0.9607 | 1.040 | 0.8570 | 1.166 | 0.8064 | 1.240 | 0.8490 | 1.177 |
| 0.75 | 1.333 | 0.9658 | 1.035 | 0.9536 | 1.048 | 0.9638 | 1.037 | 0.8631 | 1.158 | 0.8143 | 1.228 | 0.8553 | 1.169 |
| 0.76 | 1.316 | 0.9686 | 1.032 | 0.9573 | 1.044 | 0.9668 | 1.034 | 0.8691 | 1.150 | 0.8221 | 1.216 | 0.8616 | 1.161 |
| 0.77 | 1.299 | 0.9713 | 1.029 | 0.9609 | 1.040 | 0.9696 | 1.030 | 0.8750 | 1.142 | 0.8300 | 1.204 | 0.8679 | 1.152 |
| 0.78 | 1.282 | 0.9738 | 1.026 | 0.9643 | 1.036 | 0.9723 | 1.028 | 0.8809 | 1.135 | 0.8377 | 1.193 | 0.8741 | 1.144 |
| 0.79 | 1.266 | 0.9762 | 1.024 | 0.9675 | 1.033 | 0.9749 | 1.025 | 0.8868 | 1.127 | 0.8453 | 1.182 | 0.8803 | 1.136 |
| 0.80 | 1.25 | 0.9785 | 1.022 | 0.9706 | 1.030 | 0.9773 | 1.023 | 0.8926 | 1.120 | 0.8532 | 1.172 | 0.8864 | 1.128 |
| 0.81 | 1.235 | 0.9807 | 1.020 | 0.9736 | 1.027 | 0.9796 | 1.021 | 0.8983 | 1.113 | 0.8608 | 1.161 | 0.8925 | 1.120 |
| 0.82 | 1.22 | 0.9827 | 1.017 | 0.9763 | 1.024 | 0.9817 | 1.018 | 0.9041 | 1.106 | 0.8684 | 1.151 | 0.8985 | 1.113 |
| 0.83 | 1.205 | 0.9847 | 1.015 | 0.9789 | 1.021 | 0.9838 | 1.016 | 0.9097 | 1.099 | 0.8760 | 1.141 | 0.9045 | 1.105 |
| 0.84 | 1.19 | 0.9865 | 1.013 | 0.9814 | 1.019 | 0.9857 | 1.014 | 0.9154 | 1.092 | 0.8836 | 1.131 | 0.9104 | 1.098 |
| 0.85 | 1.176 | 0.9881 | 1.012 | 0.9837 | 1.016 | 0.9874 | 1.012 | 0.9209 | 1.085 | 0.8911 | 1.122 | 0.9162 | 1.091 |
| 0.86 | 1.163 | 0.9897 | 1.010 | 0.9858 | 1.014 | 0.9891 | 1.010 | 0.9265 | 1.079 | 0.8986 | 1.112 | 0.9221 | 1.084 |
| 0.87 | 1.149 | 0.9912 | 1.009 | 0.9878 | 1.012 | 0.9906 | 1.009 | 0.9320 | 1.072 | 0.9060 | 1.103 | 0.9279 | 1.077 |
| 0.88 | 1.136 | 0.9925 | 1.007 | 0.9896 | 1.010 | 0.9920 | 1.008 | 0.9375 | 1.066 | 0.9134 | 1.094 | 0.9337 | 1.071 |
| 0.89 | 1.124 | 0.9938 | 1.006 | 0.9913 | 1.008 | 0.9933 | 1.007 | 0.9429 | 1.060 | 0.9208 | 1.086 | 0.9394 | 1.063 |
| 0.90 | 1.111 | 0.9948 | 1.005 | 0.9928 | 1.007 | 0.9945 | 1.006 | 0.9482 | 1.054 | 0.9282 | 1.077 | 0.9451 | 1.058 |
| 0.91 | 1.099 | 0.9958 | 1.004 | 0.9942 | 1.006 | 0.9956 | 1.004 | 0.9535 | 1.048 | 0.9355 | 1.069 | 0.9508 | 1.051 |
| 0.92 | 1.087 | 0.9967 | 1.003 | 0.9954 | 1.005 | 0.9965 | 1.003 | 0.9586 | 1.043 | 0.9428 | 1.060 | 0.9564 | 1.044 |
| 0.93 | 1.075 | 0.9973 | 1.002 | 0.9965 | 1.003 | 0.9973 | 1.002 | 0.9637 | 1.037 | 0.9500 | 1.052 | 0.9620 | 1.039 |
| 0.94 | 1.064 | 0.9982 | 1.001 | 0.9973 | 1.002 | 0.9981 | 1.001 | 0.9687 | 1.032 | 0.9572 | 1.044 | 0.9675 | 1.033 |
| 0.95 | 1.053 | 0.9987 | 1.001 | 0.9982 | 1.001 | 0.9987 | 1.001 | 0.9736 | 1.027 | 0.9645 | 1.036 | 0.9730 | 1.027 |
| 0.96 | 1.042 | 0.9992 | 1.000 | 0.9989 | 1.001 | 0.9992 | 1.000 | 0.9785 | 1.022 | 0.9716 | 1.029 | 0.9785 | 1.021 |
| 0.97 | 1.031 | 0.9996 | 1.000 | 0.9995 | 1.000 | 0.9996 | 1.000 | 0.9833 | 1.017 | 0.9786 | 1.022 | 0.9840 | 1.016 |
| 0.98 | 1.02 | 0.9998 | 1.000 | 0.9998 | 1.000 | 0.9998 | 1.000 | 0.9880 | 1.012 | 0.9859 | 1.014 | 0.9895 | 1.010 |
| 0.99 | 1.01 | 0.9999 | 1.000 | 0.9999 | 1.000 | 0.9999 | 1.000 | 0.9927 | 1.007 | 0.9929 | 1.007 | 0.9947 | 1.005 |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

which the computations were made, $\frac{1}{R}$ being the given ratio:

$$H \ldots\ldots\ldots \frac{1 + hyp.\ log.\ R}{R}$$

$$J \ldots \frac{3.451 - 2.451 + \left(\frac{1}{R}\right)^{0.408}}{R}$$

$$K \ldots\ldots 17 \times \frac{1}{R} - 16 \times \left(\frac{1}{R}\right)^{\frac{1}{16}}$$

$$L \ldots\ldots\ldots\ldots \frac{hyp.\ log.\ R}{R - 1}$$

$$M \ldots \frac{2.451 \times \left[1 - \left(\frac{1}{R}\right)^{0.408}\right]}{R - 1}$$

$$N \ldots\ldots \frac{16 \times \left[1 - \left(\frac{1}{R}\right)^{\frac{1}{16}}\right]}{R - 1}$$

Habits of computation vary with the individual, some paying more attention to minute points than others, and some doing mentally what would compel a liberal use of pencil and paper by others. In any case the detailed descriptions of arithmetical operations are apt to make them more complicated than they really are.

We will take here a very simple case of single-stage compression. Say that we have a straight-line compressor whose air cylinder is 24-inch diameter and 36-inch stroke, piston rod 4 inches, running at 72 revolutions per minute and compressing the air to 70 lb., gage; what will be the theoretic horsepower required for adiabatic compression? The area of a 24-inch circle is 452.39 square inches, and of a 4-inch is 12.56. Then $(452.39 \times 452.39 - 12.56) \div 2 = 446$ square inches, as the mean piston area for both strokes.

As the compression is to 70 pounds, gage, the absolute pressure is $70 + 14.7 = 84.7$, and the pressure ratio is $14.7 \div 84.7 = 0.1736$. Referring to the table in the previous article to get the ratio of volumes (page 360) using column *A*, we find that for 0.17, or 0.1700, it is 0.2841, and for 0.1800 it is 0.2959, the difference being $0.2959 - 0.2841 = 0.0118$, then $0.0118 \times 0.36 = 0.004248$, and $0.2841 + 0.0042 = 0.2883$ as the ratio of volumes.

Coming now to the table before us, using column *J*, we find that for 0.2800 volume ratio, the mean effective pressure ratio is 0.5580 and for 0.2900 it is 0.5718, the difference being 0.0138, then $0.0138 \times 0.83 = 0.0114$ and $0.5580 + 0.0114 = 0.5694$ as the mean effective pressure ratio.

It is usually not necessary, or, indeed worth while to take all this pains to get the last two figures of the ratio, and in using the diagrams alone it would be much simpler. The pressure ratio, 0.1736, we would fix in our minds at 0.17⅓ +, and finding this point on the base line of the previous diagram we would read the vertical distance up to curve *A* as 0.28⅞ — . Then turning to the diagram now before us, with 0.28⅞ — on the base line, we would read the vertical distance to curve *J* as 0.57, which would be sufficiently close to the 0.5694 obtained from the table.

The absolute terminal pressure of compression being 84.7, the absolute mean effective pressure is $84.7 \times 0.5694 = 48.23$, and the working mean effective is $48.23 - 14.7 = 33.5$.

The theoretic horsepower then is: 446, mean piston area $\times$ 33.5 mean effective resistance $\times$ 6 ft. per double stroke $\times$ 72 revolutions per minute, $\div$ 33,000 foot pounds = 196 horsepower, to which is to be added what percentage information may warrant or judgment suggest.

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## Some Points on Mandrel Driving Machines

By J. Richards

Driving mandrels is not one of the most important among shop operations, but is one that calls in the tools of force—too often a heavy hammer, with a great irregularity of result and a split now and then. For this operation we have at this day in all well-regulated shops mandrel presses, levers, screws, hydraulic piston and other mandrel-driving devices, but it is to be questioned if we have any new devices that we should be proud of when we compare with those of more than three score years ago.

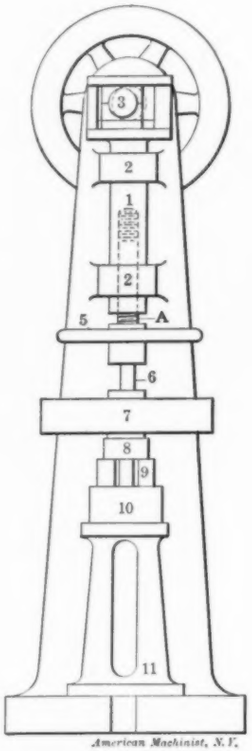



DIAGRAM OF AN OLD MANDREL DRIVING MACHINE

John G. Bodmer, an old Swiss engineer and mechanic of exalted memory, when he was struggling with high-speed steam engines—not to be really born until 40 or 50 years later—had sets of turning mandrels prepared in his shop, had also standard gages to render the mandrels possible, useful and durable, invented also a machine to drive them in and out, and this machine is our present subject; perhaps new, perhaps not.

No drawing of this machine is at hand, or has been for many years; but the sketch herewith will serve to convey the scheme to anyone not familiar with the idea of "mechanical accumulators." At 1 is a reciprocating slide or ram moving in the rigid bearings 2 by means of a crank at 3 with a short stroke of 1/16 to 1/10 inch, the shaft being driven at several hundreds of strokes per minute.

In the lower end of the ram 1 is a screw *A* with a handwheel 5 similar to a common drilling machine. At 6 is a mandrel and 7 a piece of work to receive the mandrel. At 8, 9 and 10 are chocks or distance pieces and 11 a hollow stand, but these latter-named appliances can be substituted by anything to support the work.

### Operations and Advantages

The operation is obvious, also is effective. When the wheel 5 is turned downward, it follows up the mandrel by short blows, pressing it forward with a force equal to the power of the crank at 3 very rapidly and "feels" just as if one were screwing the mandrel without strain.

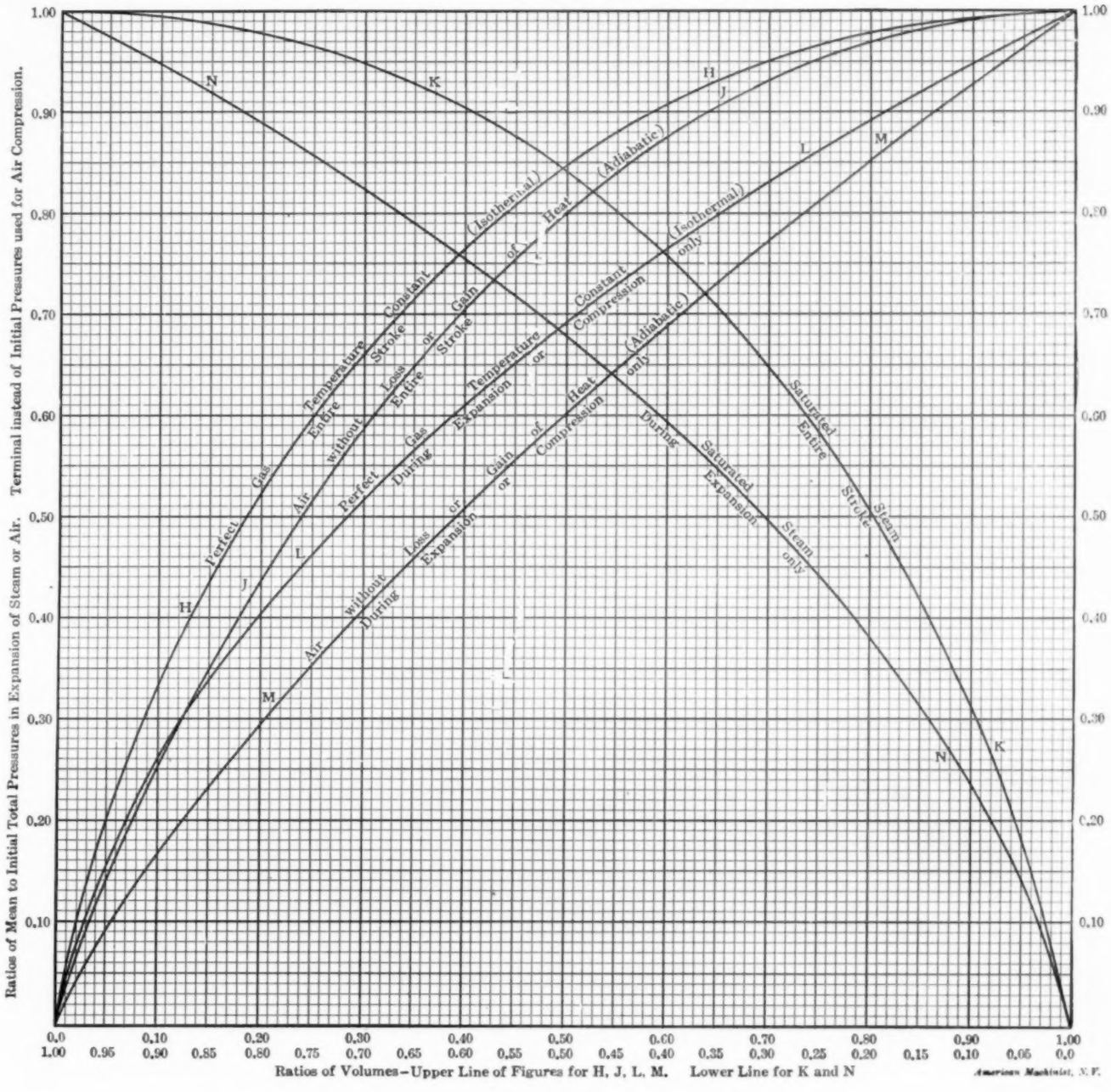
The advantages are several—there is simplicity, a low first cost and a feel of the work that enables an operator to determine the amount of strain on the work and besides the machine is always ready and adapted for use without the power when the mandrels are small.

The sketch shows an overhang or single-side machine, but a double-pillar machine is stronger and cheaper to make. I have seen a machine of this kind in competition with a hydraulic one, and selected by favor every time.

About 1886 John Walker, of the Walker Manufactory Company, Cleveland, Ohio, and I proposed to revive these old "drivers" and prepared patterns, drawings, and so on; but Mr. Walker's retirement from the Cleveland business prevented exploitation.

This "follow up" system of short, cumulative blows, illustrated by successive strokes with a hammer on nails and otherwise, has not found its way into modern machines to the extent one would suppose, perhaps not to the extent it deserves.

One application that our readers will not, perhaps, detect was in the notorious *Keeley motor*, in which the enormous pressures produced were by successive blows by "water ram," and were without limit, and it may be added without useful effect, except to deplete the pockets of credulous victims.




# Relations of Ratios of Volume and Mean Pressures in Expansion and Compression of Air

## Use of Chart

The above diagram is to be used in connection with the diagram published in the AMERICAN MACHINIST opposite page 360. The curves above show the relation between ratios of volume and mean pressure for adiabatic and isothermal compression and expansion for the whole stroke and also for only the compression or expansion portion of the stroke. As stated, at the left of the diagram, for expansion of air the mean effective pressure will be found by multiplying the initial or upper pressure by the factor obtained from the curve. For the compression of air the mean effective pressure will be found by multiplying the factor in the curve by the terminal pressure; that is, the upper pressure in both cases. As an example, let it be desired to figure the mean effective pressure in an air cylinder by adiabatic compression from atmospheric to 80-pound gage pressure at sea level in a single stage. The ratio of compression will be $(80+14.7)\div 14.7$, which equals $94.7\div 14.7$, which equals 6.44. The reciprocal of 6.44 is 0.1552.

Referring to the diagram published opposite page 360 in the AMERICAN MACHINIST and looking at curve *A* we find that the reciprocal of the ratio of pressures equal to 0.1552 on the horizontal line, is equivalent to a ratio of volume of 0.267 as measured on the vertical line at the left of the diagram. Taking this value on a horizontal line in the diagram above and following it up to curve *J* for adiabatic air compression, or expansion for the whole stroke, we find that a ratio of volume of 0.267 corresponds to a factor of 0.54, at the left of the diagram, this being the ratio of the mean to the terminal pressure in the air cylinder. The terminal pressure in the air cylinder is 94.7 lb. absolute, so multiplying 94.7 by 0.54 we have 51.1 as the total mean pressure in the air cylinder. Subtracting from this the initial pressure, 14.7, we have 36.4 pounds mean effective pressure in the air compressing cylinder.

This same process can be followed for isothermal compression for the whole stroke, or using the other curves, for either adiabatic or isothermal for the compression part of the stroke only.

# A Device for Measuring Screw Threads

## The Roller Caliper May Be Conveniently Adjusted to Suit Any Angle of Helix and to Measure Accurately Threads of Any Lead

BY M. ERIC ANDERSON

In connection with the subject of measuring screw threads in the angle of the thread as suggested by L. E. Dudley, at page 1045, Part 1, a few words might well be said regarding an interesting method of measuring such threads for pitch diameter.

As it is now well understood that the important points in the fitting and making of a thread are the pitch diameter and the lead, and that the outside and root diameters may vary considerably without affecting the fit of the male and female thread, as long as they are kept within a variation which will insure sufficient clearance at the tops and bottoms of the threads and give a long enough contact between the threads to prevent stripping, I need not dwell on why it is necessary to accurately measure threads (gages, standards, taps, accurate screws, etc.) in the angle for pitch diameter. When it becomes necessary to maintain a set of standards, gages and precision threads in a factory in which the finest of work is required, a very accurate method of measuring is necessary. Such a system was evolved to meet the needs of the S. S. White Dental Manufacturing Company by A. W. Browne, some 12 or 15 years ago, and is, I have heard, now adopted by a number of shops throughout the country.

The instrument used in this system is known as the "roller caliper." It has a line contact with the threads which is almost a surface contact. Its construction permits of the most accurate workmanship, it being a comparatively simple matter to grind and lap the measuring rollers practically perfect. It can be accurately set to the lead angle or angle of the helix, thus insuring a proper line contact and avoiding interference with other parts of the thread, which is the only proper way to measure a thread, and in my opinion, all threads should be so cut, with the 60-degree angle at right angles to the lead angle, to permit of uniform results and permit them to be so measured.

The contact rollers being interchangeable permit of three micrometer frames handling a range of work from 0 to 2⅝ inches in diameter, and 10 double contact rollers and one single roller handling a range of threads from 8 to 100 to the inch. The design of the outfit also permits of adjusting by final fitting and lapping to perfect alinement of the contact rollers.

The contact rollers have a great advantage as regards wear, as at the points of the V's, which are the most delicate places the circumference of the rollers is longest, thus greatly increasing their durability, and as the rolls are interchanged, it seldom happens that the usage will come in exactly the same spot twice.

In fact, in the "roller caliper" we have durability, high degree of accuracy, sensitiveness and in the long run, if not in first cost, economy.

The accompanying illustrations show the roller caliper in detail. Figs. 1 and 2 show the contact rollers and other accessories attached to a 2-inch micrometer frame and with a range from 0 to ¾ inch pitch diameter. Figs. 3 and 4 show the micrometer frame pieced out to take ranges up to 1½ and 2⅝ inches, respectively. These are pieced out instead of a large frame micrometer being used, to give a straight uniform way for the sliding member, shown in Fig. 5, which holds the single contact roller in alinement.

Fig. 2 shows the graduated segment and the arm which swings the double contact roller to the proper angle. Referring to Fig. 6, which shows the details of the angle-adjusting mechanism, it will be noted that the segment divisions are doubled; that is, when the contact roller is swung 5 degrees by the graduations it actually is moved 10 degrees. This is because the single contact roller is stationary and, therefore, the double roller has to swing twice the lead angle to make up, as we have the amount of the lead angle on both sides of the thread but in opposite directions to contend with.

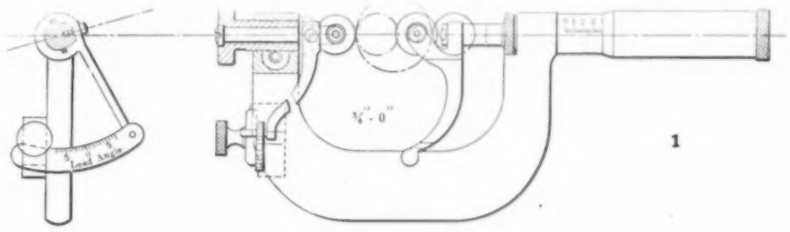


FIG. 1 FIG. 2

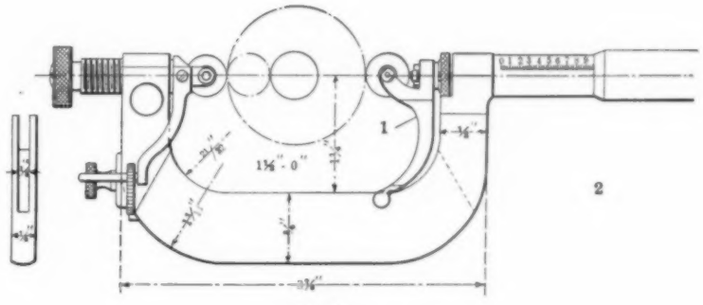
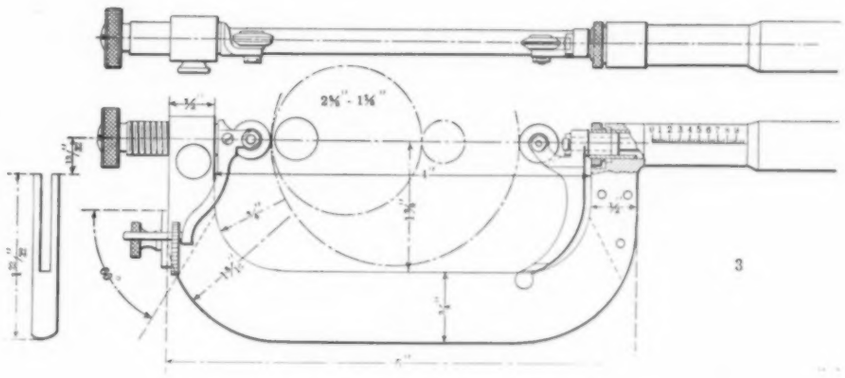


FIG. 3



ROLLER CALIPERS FOR MEASURING SCREW THREADS

Fig. 7 shows the set of 10 double contact rollers whose construction is so simple as to require no explanation. A set of 10 single rollers can also be made with a diameter of 0.437 inch, and with a width of flat on the circumference for each respective lead corresponding to the width of clearance groove between the two parts of the double rollers. These will give the greatest amount of durability, but for all practical purposes a single roller ground eccentric on the circumference to give varying widths of flat, as shown by Fig. 8, and turned to present the proper width of flat to the thread it is measuring is more convenient and perfectly satisfactory.

It would also be possible, if found desirable, to use one double-contact roller for measuring all pitches, by grinding the outside angles (which do not come in contact when measuring) of both sides eccentric to the hole and to the inside angles. This would give the entire range of dimensions from 0.008 to 0.070 inch, shown in Fig. 7, between the edges of the rollers, and the roller could be turned on

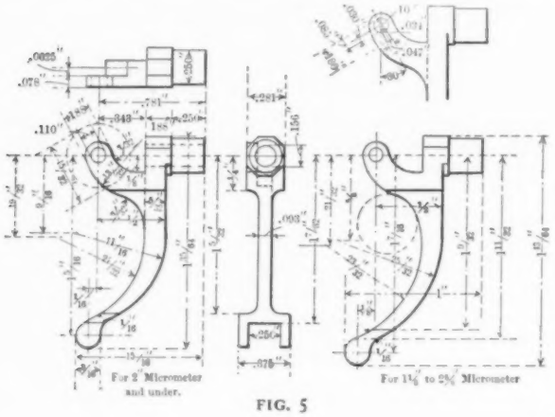



FIG. 5

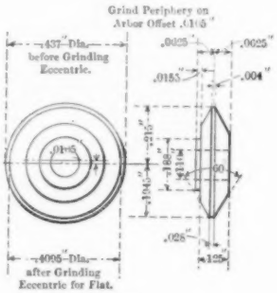



FIG. 8

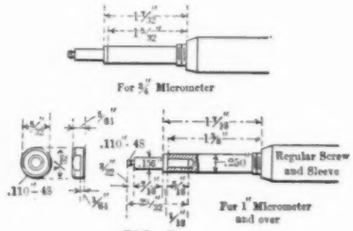



FIG. 9

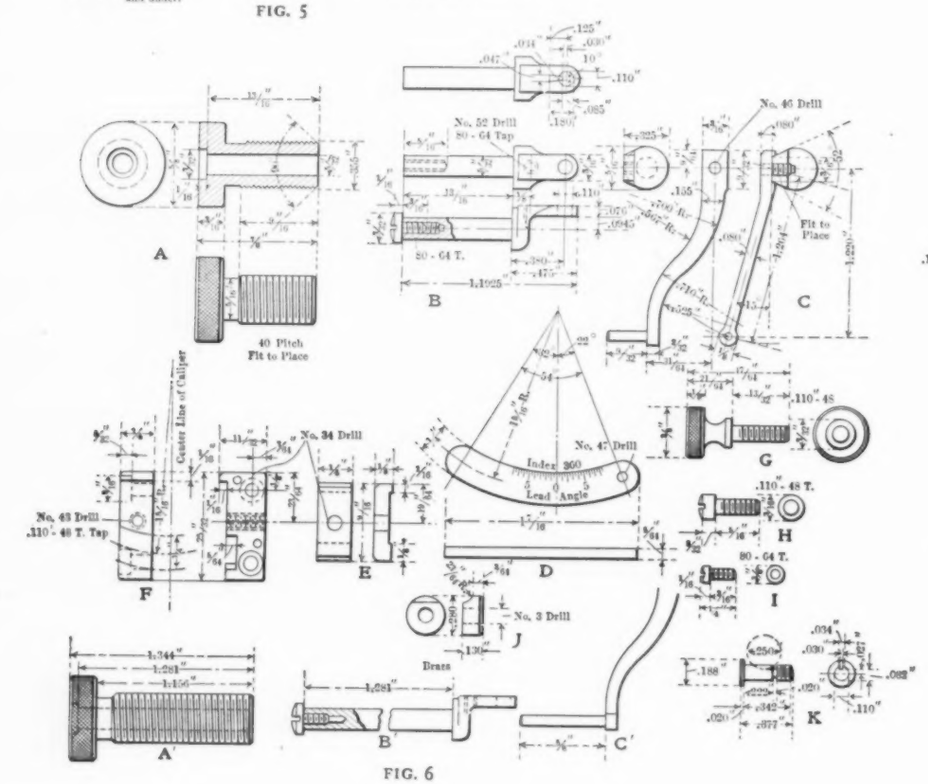



FIG. 6

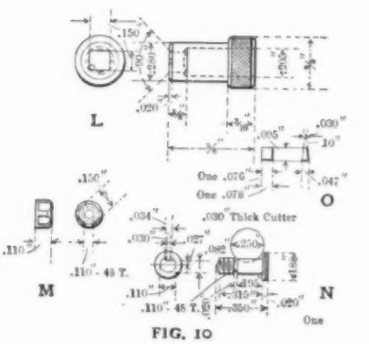



FIG. 10

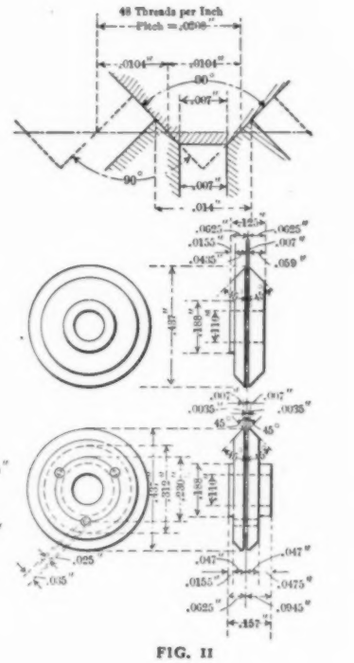



FIG. 11

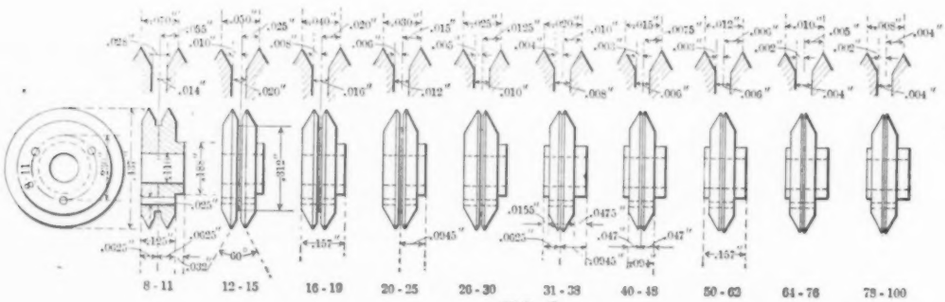



FIG. 7

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ROLLER CALIPER DETAILS

the stud to the proper position to take care of the different leads. The table gives an easy formula for finding the lead angle in degrees by which to set the roller caliper. The figures worked out in it apply to a large number of threads already in use and by these figures any of the new standard lead angles can be closely approximated.

A brief explanation of the details shown of the roller caliper may be of interest. Fig. 5 shows the sliding member which holds the single roller in alinement and which is carried on the end of the micrometer spindle. The upper detached view shows the method of keying the roller stud.

Fig. 6 shows the entire double roller-carrying and angle-adjusting mechanism. *A* is an adjusting screw accurately tapped into the anvil end of the micrometer frame and allowing *B*, the roller-carrying pivot, to swivel in it. *A* is used for adjusting the roller caliper to the initial or zero reading before taking a measurement. At *B* is also shown the thrust screw and the upper detached view shows the method of keying the roller stud. The angle adjusting arm is shown at *C* and also the way in which it is fastened to *B* by screw *I*. *D* is the angle-adjusting segment with a hole at one end which is a sliding fit on the pin projection of *C*. Parts *E*, *F*, *G* and *H* form the segment-clamping device by which the angle mechanism is held in position and which, by *F* and *H*, is fastened to the side of the micrometer frame. *J* is a clamping block for *A* and is operated by the regular micrometer clamping screw. *K* is the carrying stud for the double roller. *A'*, *B'* and *C'* are simply modifications of *A*, *B* and *C* as used in the roller caliper, Figs. 1 and 2, to suit the roller caliper shown in Figs. 3 and 4.

Fig. 9 shows how the micrometer spindle is modified to receive the sliding member, Fig. 5, and the thrust nut which takes out all end play.

Fig. 10 shows at *L* the little socket wrench for loosening or tightening the roller-stud nuts *M*. It will be noticed that the nuts are made a snug fit in the wrench so that when they are removed they will be retained until they are put back, a point which anyone who has hunted on the floor for a small expensive nut will appreciate. *N*, Fig. 10, is the carrying stud for the single roller, which fits in the sliding member shown in Fig. 5. *O* is the form of key used to prevent the carrying studs from turning when turning the rollers or tightening the nuts *M*. The detached views in Fig. 5 and at *B*, Fig. 6, show it in place.

Fig. 11 is simply given as an illustration of how this roller caliper may be adapted to measure threads other than those having the regular 60-degree angle. The rollers shown are for measuring a 90-degree thread with 48 threads per inch and the enlarged layout shows graphically the method of determining the length of the line of contact. In this case it was deemed best to have the line of contact extend ⅓ of the length of the sharp V depth, or 1/6 above and 1/6 below the pitch diameter on the double roller. The single roller extends to ⅓ the depth of the sharp V but, of course, having no relief, has a line contact to the outside diameter of the thread. The 60-degree rollers were made in the same way but as they each cover a range of slightly varying leads, the figures to which they are laid out represent an average of the different "threads per inch" for which they are intended.

I might add, to avoid misunderstanding, that the names, roller caliper and con-

| Threads per Inch | Roller Caliper Diameters | | |

tact rollers, are really misnomers; that the rollers do not roll in measuring but are securely clamped by the studs. I believe that the original idea was to allow them to roll but it was found that enough freedom to permit them to turn could not be allowed and the degree of accuracy required in the measurements still be maintained.

Cotangent of Lead Angle = Diameter x No. of Threads x $\pi$

| Threads per Inch | Roller Caliper Diameters | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | .200 | .210 | .220 | .230 | .240 | .250 | .260 | .270 | .280 | .290 | .300 | .325 | .350 | .375 | .400 | .450 | .500 | .550 | .600 | .650 | .700 | .750 | .800 | .900 | 1.000 | 1.100 | 1.200 | 1.350 | 1.500 | 1.750 | 2.000 |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | 4½ | 4½ | 3½ | 3½ | 3 | 2½ | 2¼ |
| 5 | | | | | | | | | | | | | | | | | | | | | | | 4 | | 3½ | 3½ | 3 | 2½ | 2½ | 2 | 1¾ |
| 6 | | | | | | | | | | | | | | | | | | | | | | 3½ | 3½ | | 3 | 2¾ | 2½ | 2½ | 2 | 1¾ | 1½ |
| 7 | | | | | | | | | | | | | | | | | | | | 3½ | 3½ | 3½ | 3 | | 2½ | 2½ | 2¼ | 2 | 1¾ | 1½ | 1⅜ |
| 8 | | | | | | | | | | | | | | | | | | | 3½ | 3½ | 3 | 2½ | 2½ | | 2½ | 2½ | 1⅞ | 1¾ | 1½ | 1½ | 1¼ |
| 9 | | | | | | | | | | | | | | | | | | 3½ | 3½ | 3½ | 3 | 2½ | 2½ | 2¼ | 2 | 1⅞ | 1¾ | 1½ | 1½ | 1⅜ | 1 |
| 10 | | | | | | | | | | | | | | | 4 | 3½ | 3½ | 3 | 2½ | 2½ | 2½ | 2½ | 2 | | 1¾ | 1⅝ | 1½ | 1⅜ | 1½ | 1 | ⅞ |
| 11 | | | | | | | | | | | | | 4¼ | 4 | 3½ | 3¼ | 3 | 2¾ | 2½ | 2⅜ | 2½ | 2½ | 1⅞ | | 1⅝ | 1⅝ | 1⅜ | 1⅜ | 1⅜ | 1 | ⅞ |
| 12 | | | | | | | | | | | | 4½ | 4 | 3½ | 3½ | 3 | 2¾ | 2½ | 2⅜ | 2⅜ | 2 | 1⅞ | 1½ | | 1⅜ | 1⅜ | 1½ | 1⅜ | 1 | ⅞ | ⅝ |
| 13 | | | | | | | | | | 4½ | 4½ | 4 | 3½ | 3½ | 3½ | 2¾ | 2½ | 2½ | 2½ | 2 | 1⅝ | 1⅝ | 1½ | | 1⅜ | 1⅜ | 1⅜ | 1 | ⅞ | ⅝ | .. |
| 14 | | | | | | | | | | 4½ | 4 | 3½ | 3½ | 3½ | 2½ | 2½ | 2½ | 2½ | 2 | 1⅞ | 1½ | 1½ | .. | | .. | .. | 1⅜ | .. | .. | .. | ⅝ |
| 15 | | | | | | | | | 4½ | 4 | 3½ | 3½ | 3½ | 3 | 2½ | 2½ | 2½ | 2 | 1⅞ | 1½ | 1½ | 1½ | 1½ | | 1⅜ | 1⅜ | 1 | ⅞ | ⅝ | .. | .. |
| 16 | | | | | | | | 4½ | 4 | 3½ | 3½ | 3½ | 3 | 2½ | 2½ | 2½ | 2 | 1⅞ | 1½ | 1½ | 1½ | 1½ | 1½ | | 1⅜ | 1 | ⅞ | .. | .. | ⅝ | .. |
| 18 | | | | | 4 | 3½ | 3½ | 3½ | 3½ | 3½ | 3½ | 2½ | 2½ | 2½ | 2½ | 2 | 1⅞ | 1½ | 1½ | 1½ | 1½ | 1½ | 1½ | | 1 | ⅞ | .. | ⅝ | ⅝ | .. | ⅝ |
| 20 | | | 4½ | 4 | 3½ | 3½ | 3½ | 3½ | 3½ | 3 | 2½ | 2½ | 2½ | 2½ | 2 | 1⅞ | 1½ | 1½ | 1½ | 1½ | 1½ | 1½ | 1 | | ⅞ | .. | ⅝ | ⅝ | .. | ⅝ | ⅝ |
| 22 | | 3½ | 3½ | 3½ | 3½ | 3½ | 3½ | 3½ | 3 | 2½ | 2½ | 2½ | 2½ | 2½ | 1⅞ | 1½ | 1½ | 1½ | 1½ | 1½ | 1½ | .. | .. | | .. | ⅝ | ⅝ | .. | ⅝ | .. | ⅝ |
| 24 | 3½ | 3½ | 3½ | 3½ | 3½ | 3½ | 3 | 2½ | 2½ | 2½ | 2½ | 2½ | 2 | 1½ | 1½ | 1½ | 1½ | 1½ | 1½ | 1½ | 1 | 1 | ⅞ | | ⅝ | ⅝ | .. | ⅝ | .. | ⅝ | .. |
| 26 | 3½ | 3½ | 3½ | 3 | 2½ | 2½ | 2½ | 2½ | 2½ | 2½ | 2½ | 2 | 1⅞ | 1½ | 1½ | 1½ | 1½ | .. | 1½ | .. | .. | .. | .. | | .. | .. | .. | .. | .. | .. | ⅝ |
| 28 | 3½ | 3⅜ | 3 | 2½ | 2½ | 2½ | 2½ | 2½ | 2½ | 2⅜ | 2 | 1⅞ | 1½ | 1½ | 1½ | 1½ | 1½ | 1½ | 1 | 1 | ⅞ | ⅞ | ⅞ | | ⅞ | .. | ⅞ | .. | ⅞ | .. | .. |
| 30 | 3 | 2½ | 2½ | 2½ | 2½ | 2½ | 2½ | 2½ | 2 | 2 | 1⅞ | 1½ | 1½ | 1½ | .. | .. | .. | .. | .. | .. | ⅝ | .. | .. | | ⅝ | ⅝ | ⅝ | ⅝ | .. | .. | .. |
| 32 | 2⅞ | 2½ | 2½ | 2½ | 2½ | 2½ | 2 | 2 | 1⅞ | 1⅞ | 1½ | 1½ | 1½ | 1½ | 1½ | 1½ | 1 | ⅞ | ⅞ | ⅝ | ⅝ | ⅝ | ⅝ | | ⅝ | .. | ⅝ | .. | .. | ½ | .. |
| 34 | 2½ | 2½ | 2½ | 2½ | 2½ | 2½ | 2 | 1⅞ | 1⅞ | 1⅞ | 1½ | 1½ | 1½ | 1½ | 1½ | 1 | ⅞ | .. | ⅝ | .. | ⅝ | .. | .. | | .. | .. | .. | .. | .. | .. | .. |
| 36 | 2½ | 2⅜ | 2½ | 2½ | 2½ | 2 | .. | 1⅞ | 1⅞ | .. | .. | .. | .. | .. | .. | .. | .. | .. | ⅝ | .. | .. | .. | .. | | .. | .. | .. | .. | .. | .. | .. |
| 38 | 2⅜ | 2¼ | 2½ | 2 | 2 | 1⅞ | 1⅞ | 1⅞ | 1⅞ | 1⅞ | 1⅞ | 1⅞ | 1¾ | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | | .. | .. | .. | .. | .. | .. | .. |
| 40 | 2¼ | 2⅛ | 2 | .. | 1⅞ | 1¾ | 1½ | 1⅝ | 1⅝ | 1⅝ | 1⅝ | 1¾ | 1⅝ | 1⅝ | 1 | ⅞ | .. | ⅝ | ⅝ | ⅝ | ⅝ | ⅝ | ⅝ | | .. | .. | .. | .. | ¾ | .. | .. |
| 42 | 2⅛ | 2 | .. | 1⅞ | 1½ | .. | 1½ | .. | 1½ | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | | ⅝ | ⅝ | .. | ¾ | .. | .. | |
| 44 | 2 | .. | 1⅞ | 1½ | .. | 1½ | .. | 1½ | .. | 1⅜ | 1⅜ | 1⅜ | 1 | .. | ⅞ | ⅝ | ⅝ | .. | ⅝ | .. | ⅝ | .. | .. | | .. | .. | .. | .. | .. | .. | |
| 46 | 2 | 1⅞ | 1½ | .. | 1½ | .. | 1½ | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ⅝ | .. | ⅝ | .. | .. | ⅝ | | .. | .. | .. | .. | .. | .. | |
| 48 | 1⅞ | 1½ | .. | 1½ | .. | 1½ | .. | 1⅜ | 1⅜ | 1⅜ | 1⅜ | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | | .. | .. | ½ | .. | .. | | |
| 50 | 1½ | .. | 1½ | .. | 1½ | .. | 1½ | .. | 1½ | .. | .. | .. | .. | .. | .. | .. | ⅝ | .. | ⅝ | .. | .. | .. | .. | | .. | .. | .. | | | | |
| 52 | .. | 1½ | .. | 1½ | .. | 1⅜ | .. | 1¼ | .. | 1⅜ | 1 | 1 | ⅞ | ⅞ | ⅞ | .. | .. | .. | .. | .. | .. | .. | .. | | .. | ¾ | .. | | | | |
| 54 | 1½ | .. | 1½ | .. | 1⅜ | .. | 1½ | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ⅝ | .. | .. | .. | ⅝ | .. | | .. | .. | .. | | | | |
| 56 | .. | 1½ | .. | 1⅜ | .. | 1½ | .. | 1½ | 1½ | .. | .. | .. | .. | .. | .. | ⅝ | .. | .. | .. | ⅝ | .. | .. | .. | | ¾ | .. | .. | | | | |
| 58 | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 1 | ⅞ | ⅞ | ⅝ | ⅝ | ⅝ | .. | ⅝ | .. | .. | .. | .. | .. | .. | | .. | .. | | | | | |
| 60 | 1⅛ | 1⅛ | 1⅛ | 1⅛ | 1⅛ | .. | 1⅛ | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ⅝ | .. | .. | .. | | .. | .. | | | | | |
| 62 | .. | .. | 1⅛ | .. | 1⅛ | 1⅛ | .. | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ¾ | | .. | | | | | | |
| 64 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | | .. | | | | | | |
| 66 | 1⅛ | .. | .. | .. | .. | .. | .. | .. | .. | ⅞ | ⅞ | ⅞ | .. | .. | .. | .. | .. | .. | ⅝ | .. | .. | .. | .. | | .. | | | | | | |
| 68 | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ¾ | .. | | | | | | | | |
| 70 | 1⅛ | 1⅛ | 1⅛ | 1⅛ | .. | 1 | .. | .. | ⅞ | .. | .. | .. | .. | ⅝ | ⅝ | ⅝ | ⅝ | .. | .. | .. | ¾ | .. | .. | | | | | | | | |
| 72 | .. | .. | .. | .. | .. | .. | .. | ⅞ | .. | .. | .. | .. | .. | .. | .. | .. | ⅞ | ⅞ | .. | .. | .. | .. | .. | | | | | | | | |
| 74 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | | | | | | | | | |
| 76 | .. | .. | .. | .. | 1 | .. | ⅞ | .. | ⅝ | ⅝ | .. | ⅝ | .. | .. | .. | .. | .. | .. | .. | .. | .. | | | | | | | | | | |
| 78 | 1⅛ | 1⅛ | 1 | 1 | .. | ⅞ | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | | | | | | | | | | |
| 80 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ⅝ | .. | ⅝ | ⅝ | ⅝ | ⅝ | .. | .. | ⅝ | ⅝ | | | | | | | | | | | |
| 82 | .. | .. | .. | .. | ⅞ | .. | .. | ⅝ | ⅝ | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | | | | | | | | | | | |
| 84 | .. | 1 | .. | ⅞ | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | | | | | | | | | | | |
| 86 | 1 | .. | .. | .. | .. | .. | ⅝ | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | | | | | | | | | | | | |
| 88 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | | | | | | | | | | | | |
| 90 | .. | .. | ⅞ | .. | .. | ⅝ | .. | .. | .. | .. | ⅝ | .. | .. | .. | .. | .. | .. | .. | ⅝ | | | | | | | | | | | | |
| 95 | .. | ⅞ | .. | ⅝ | ⅝ | .. | .. | ⅝ | ⅝ | ⅝ | .. | ⅝ | ⅝ | .. | .. | .. | .. | .. | | | | | | | | | | | | | |
| 100 | ⅞ | .. | .. | .. | .. | .. | ⅝ | .. | .. | .. | ⅝ | .. | .. | ⅝ | .. | .. | .. | ⅝ | | | | | | | | | | | | | |
| 110 | .. | ⅝ | ⅝ | .. | .. | .. | .. | .. | .. | ⅝ | .. | .. | .. | .. | ⅝ | .. | .. | | | | | | | | | | | | | | |

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TABLE 2. LEAD ANGLES (DEGREES) OF SCREW THREADS

The total cost of the buildings erected in the principal cities of the United States in 1908 was $546,467,390, according to the United States Geological Survey, which has collected statistics on this subject in connection with investigations of the clay-working industries.

## First Steel Mill in South America

A very important step in the industrial progress of Chile, and for that matter all of South America, is being recorded in the construction of a large steel plant at Corral, which is expected to be completed and in operation early next year. It is the first steel plant south of Mexico, and will cost approximately $2,000,000, the financing of which is being carried on by French capital. Its location is extremely favorable for within five miles distance are to be found immense quantities of a fine quality of iron ore, so that it is intended to transport the ore to the mill by means of an overhead cable, which taken in connection with the immense forests located in the vicinity, from which it is intended to draw the first fuel, will tend to keep maintenance costs low. The plant is to be thoroughly modern and is designed to produce 200 tons of steel per day. The opening of this plant on such large and uptodate lines is expected to encourage the development of many other industries dependent upon iron and steel for their raw material. Should the plant materialize according to expectations its successful operation will, no doubt, be a large factor in South American industrial advancement.

# Practical Letters from Our Readers

## A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

## WE PAY FOR USEFUL IDEAS

### An End Mill, a Hollow Mill and a Chuck

We do considerable slabbing work in our shop, such as hexagonal brass valves, nuts, etc. It had been the custom to use the common style of slabbing cutter, shown in Fig. 1. These cutters are expensive to make and it happened that the boss received an order from the brass-finishing department for a couple of dozen of different sizes when he could ill afford the time for this work.

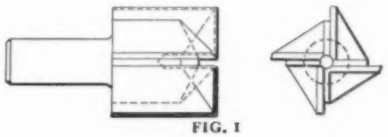

FIG. 1

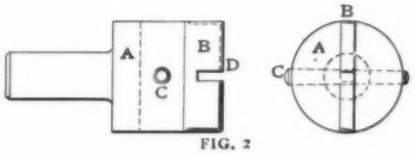


FIG. 2

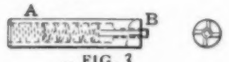


FIG. 3

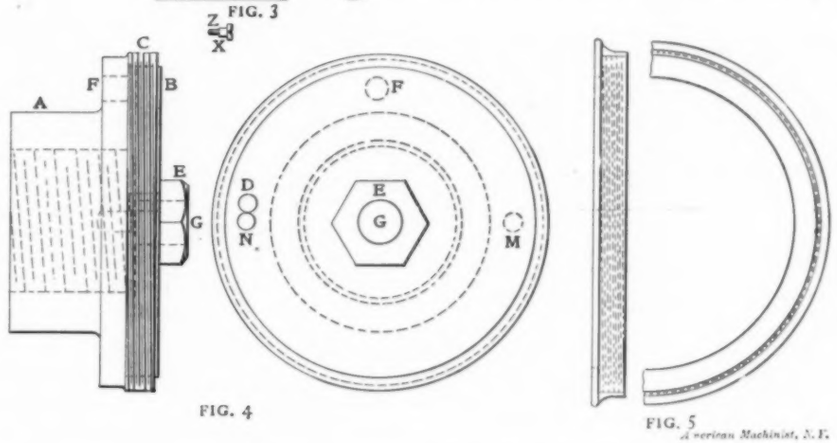


FIG. 4



FIG. 5

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AN END MILL A HOLLOW MILL AND A CHUCK

This set him to thinking of some design of cutter which would have an inserted blade that could be easily replaced when worn out. The cutter shown in Fig. 2 was the result, and has proved so satisfactory that it has replaced the old style entirely.

*A* is the holder, made of cold-rolled stock. This is slotted for the blade *B*, which is made of 5/32-inch stock. *C* is a taper pin that holds *B* firmly against the bottom of the slot. *D* is a slot made to enable the operator to grind the blade easily.

The body *A* is made in three sizes, which cover the entire range of the work done on the slabbing machines. A jig was made to drill and ream the blades *B*, so that they would all come alike. In talking with the operator he said he found that they did the work very satisfactorily, and they were much easier for him to grind, having only two faces, while the other style had four, and as the company did not care to go to the expense of having a small fixture made to grind them with, it was often an indifferent job that was done by hand on the emery wheel.

Fig. 3 shows a handy little hollow mill. The small screw shown is made of brass, and difficulty was experienced with the shoulder *X* in trying to get them the same size. As they were a stock screw and bought by the gross outside, *X* would be all sizes. But the mill shown remedied this nicely. *A* is the body with the hole the right size for *X*. *B* is a plunger with a hole into which the screw *Z* is an easy fit; it guides the screw while being milled. In sizing the screws the mill is placed in the chuck of the speed lathe. The screw *Z* is placed in the plunger and the operator with the aid of a screwdriver forces the screw in until the mill touches the shoulder. The pressure is then released, the plunger by the aid of the spring forces it out and it is picked off and another one is ready.

Fig. 4 is a special chuck for holding the brass-gage cover, shown in Fig. 5, while being turned on the outside. It had been the custom to turn these covers on a solid chuck, but this method often proved troublesome, some of them sticking so hard that the pounding with a wooden mallet required to loosen them often left them in a warped state.

The new chuck, however, relieved all this trouble. *A* is the body threaded at the back to fit the spindle of the lathe and at the front for the part *B*. *C* is the thread on which the cover is screwed while being turned.

To operate the chuck, the part *B* is turned around until the pin *D* comes in contact with the pin *N* in *A*. Then the cover is screwed on up to *B*. When the cover is finished a wrench is placed on the nut *E*, and *B* having a right-hand thread, is brought around toward the pin *M*. This releases the strain on the cover so that it can easily be unscrewed by the hand. The hole *F* is used in case the pin *D* has to be driven out to unscrew *B* from *A*. The hole *G* was used to turn *B* on an arbor.

Boston, Mass. PEDRO.

### Producer Gas for Babbitting Furnaces

At a manufacturing plant equipped with a gas-producer power plant, an additional advantage was developed for the gas producer, namely, the use of the gas for babbitting and soldering furnaces about the shops.

A 2½-inch pipe was run from one of the gas mains to an exhauster in the power house, the exhauster being belt driven from one of the engines. From the exhauster the 2½-inch pipe was continued to the shops, smaller pipes being led off for the separate furnaces.

The pressure in the line was kept up to about 1 pound by means of a bypass valve arranged as follows: The suction and discharge pipes, both of which were vertical at the exhauster, were connected by a smaller pipe, at the center of which was located an especially made casing containing the bypass valve.

The valve itself was a simple casting having an annular bearing surface at the bottom, about 1/16 inch in width. It was weighted with lead so that when the pressure in the line became more than a pound, the valve would be forced up, allowing back pressure to the suction. The valve could be easily removed by taking off the cover on top of the casing. The babbitting furnace consisted of a cylindrical casting about 2 feet in diameter, open at the bottom and having an opening in the top of sufficient size to hold the melting pot.

The furnace was lined with firebrick and supported by four legs about 6 inches long. The burner which was connected to the line by a ¾-inch pipe, was placed in the center of the furnace; a peep hole being provided for observing the flame.

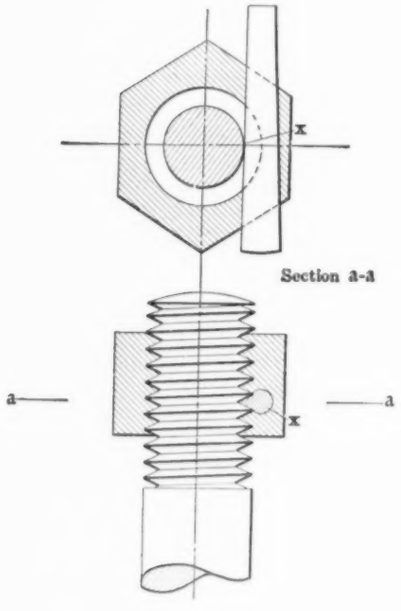
The burner itself was a vase-shaped casting about 8 inches long, into the bottom of which was screwed a piece of ½-inch pipe of such length that it passed up to the neck of the burner which at that point was about ¾ inch in diameter. The gas entered at the side of the burner and the proper combustion was secured by screwing the pipe up or down. A heater for soldering irons was made by slotting a piece of 1x6-inch pipe with a hacksaw at ½-inch intervals.

Some difficulty was experienced with the bypass valve sticking and getting coated, when an inferior grade of coal was used in the producers, but as the valve was easily removed, it could be quickly cleaned. With the better grades of coal, no difficulty at all was experienced, and the system proved very satisfactory and economical.

Chicago, Ill. O. W. MIDDLETON.

## A Nut Lock

The illustration shows a nut made to meet certain special conditions. I have




A NUT LOCK

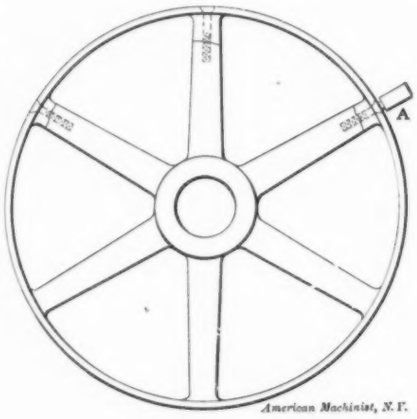
used some as lock nuts on an automobile with good results.

The locking device consists of a tangential pin driven through a hole in the nut as shown. The hole has to be drilled so as to cut away part of the thread in the nut at *X*. The pin is made with a slight taper and the section conforms to the thread. To prevent the pin from jarring loose the projecting part can be bent over.

Newark, N. J. ARTHUR LOWRY.

## A Pulley Repair

A 42-inch pulley with elliptical arms was broken as shown in the sketch, and a quick repair was needed. The ¾-inch tap drill was run down into each broken arm, a clearance drilled out down to the break, and the holes countersunk. Three screws with countersunk heads were made and partly cut off from the bar, as at *A*, a carrier put on and then they were sent in as tight as a 12-inch wrench could make them go. The bar was then cut off and the countersunk heads riveted down. The breaks were closed so tight as to be




A PULLEY REPAIR

hardly visible, and in less than two hours the job was on its way back to the owner.

SAMUEL H. RALSTON.

Norristown, Penn.

[If the breaks were shrinkage cracks this looks like poor practice—ED.]

## How Can Rolled Wire Be Kept Straight?

Having endless trouble in getting straight rolled metal, I shall be pleased if any AMERICAN MACHINIST readers can give a reliable method. The metal, in the first place, is round steel wire, and is rolled flat to ¼ inch wide by 20 Birmingham wire gage. There is no trouble in keeping it straight if rolled hard, but it is required soft enough to be drawn in drawing dies, yet not dead soft, as if it is dead soft it is difficult to keep out the kinks in feeding it through a guideway on the dies. Any process of annealing the metal after hard rolling would be of service, but the metal must be kept bright or straw color. It is made up in reels with about 28 pounds in one length.

Liverpool, England. W. EDGE.

## A Ball Center and a Gage for the Power Hack Saw

Fig. 1 shows a ball center which I use for sizing blanks when trying drawing punches and also for supporting large jobs held in the jaw chuck.

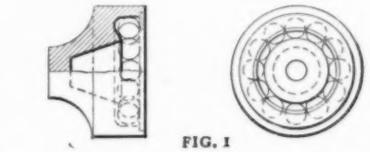


FIG. 1

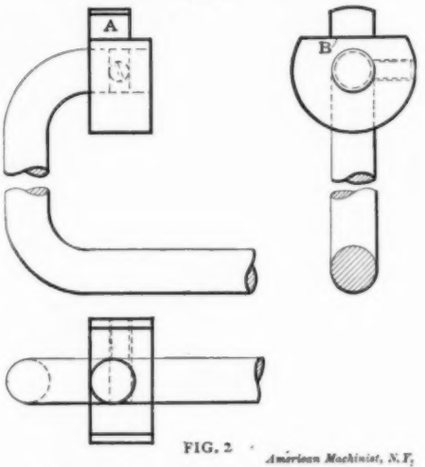



FIG. 2 *American Machinist, N.Y.*

A BALL CENTER AND A HACKSAW GAGE AND REST

Fig. 2 is a combined gage and work support for the hacksaw. These machines are sent out equipped with a gage as depicted here by the lighter lines. This is all right as a gage, but with the dulling of the saw when in use comes the need for a support for the outer end of the material being sawed; hence we see the gage being used as a rest; then each piece cut off must be measured separately. As shown here, the part *A* serves as a gage, the material being supported on the surface *B*. As will be seen, it is quickly made and applied, and may be used for all diameters of stock and, of course, for all lengths. A groove is filed in the existing gage, and a small grub screw holds it in the proper position.

Birmingham, England. WULFRUNA.

Samples of air at a hight of nearly nine miles have been recently obtained and examined for the presence of the rare gases. The collecting apparatus, carried by a large balloon, is a series of vacuum tubes, each drawn out to a fine point at one end. At the desired hight an electromagnetic device, connected with each tube and operated by a barometer, breaks off the point of the tube, admitting the air. A few minutes later a second contact sends a current through a platinum wire around the broken end, melting the glass and sealing the tube. All the samples obtained show argon and neon, but no helium was found in air from above six miles.—*The Engineer.*

# Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

## WE PAY FOR THESE ALSO

### More Points on the Hob Question

I was pleased to see that on page 168 Mr. Thompson, whose article on the Humpage patent hob was commented on by myself for the purpose of creating a discussion on the subject of hobs generally, had joined in the discussion, and I trust that other users and makers of hobs will have something to say that will bring out further points.

There is one point on which there is perfect agreement between Mr. Thompson and myself: we both believe in the future of the hobbing process for the production of commercially accurate spur gears, whatever form the hob may take, and this in itself (the form of the hob) is only a question of evolution. There are, however, several points where we differ, and I will take them in rote as they appear in Mr. Thompson's article. It might be stated here that I advocate a deviation from the straight sides generally found on hob teeth, and this advocacy took the form of a short article which appeared in the European edition of the AMERICAN MACHINIST, page 341 E, Part 1 of the present volume, and was written prior to the publication of Mr. Thompson's article on the Humpage hob. This article need not be quoted farther than to say that "by getting away from the straight-sided hob we can clear away *slightly* the tips of the teeth, this being the part that gives the abnormal noise when running at high speeds."

Mr. Thompson, in commenting on this point, says: "When the tips have been cleared away in this manner, of what use are they at all? Since they do not touch, would not the same effect be produced by putting the wheel in a lathe and turning off the tips of the teeth altogether?"

This argument was advanced by a previous writer on gears, who was advocating stub teeth, and the answer is: Just as a suspended drop hammer represents potential energy, so may the tips of the teeth be said to represent potential wearing surfaces, and a few lines lower than my quotation Mr. Thompson shows that this is well known to him, for he says: "Also as the teeth wear will they not in time wear to the true involute form even if the points were originally eased off."

Mr. Thompson asserts that the Bilgram machine generates teeth of the true involute form. This is not so, and yet it is an undeniable fact that the teeth produced on a Bilgram machine are among the finest examples of gear cutting, both for accuracy, quietness and smoothness in running. How can the Bilgram cut true involutes when it is only supplied with 22 rolling cones to cover the range of its product? As a further proof that the Bilgram does not cut true involutes, and to strengthen my case for the easing away of the points, may I quote from Howard A. Coomb's book, "The Art of Generating Gear Teeth," which, by the way, is a reprint from the AMERICAN MACHINIST. On page 91 Mr. Coombs says: "A later improvement patented by Mr. Bilgram early in 1904 consists in slightly curving the tangential path of the tool relatively to the blank, the object being to relieve the teeth at the points and near the bases, whereby they run more quietly at high speeds.

Mr. Thompson points out "that if we take a straight-edge and lay along the top of the teeth parallel to the cutting face

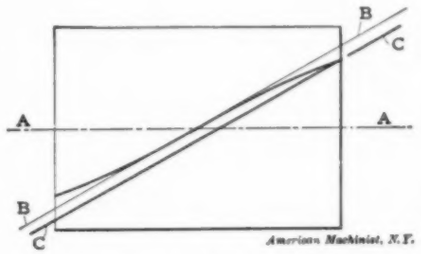



FIG. 1. DIAGRAM OF LINE OF TEETH AND SETTING ANGLE OF HOB

of an ordinary hob it will rock, proving that the teeth are as a segment of a large gear wheel." This is so, and this fact is the base of my contention that the fetish of the straight side should be dropped. There need be no guesswork, as the radius of this curve can be calculated and the involute to the radius worked out (if anyone likes to take the trouble), and naturally the side of the hob teeth would be a curve. In the book, "Worm and Spiral Gearing," by F. A. Halsey, page 90, a formula is given, which, by a simple transformation, will give this radius.

Mr. Thompson further points out that there is a difference in pitch between the top and bottom of the teeth of a hob that is grooved normal to the thread; this is so, but this does not account for the tips being thick, as any variation in the pitch of a hob, whether it be + or —, must of necessity result in the removal of some part of the tooth, consequently, if the pitch at pitch line is correct, a difference in pitch at the root of the hob would result in a slight easing away at the points of the teeth being cut. Moreover, the pitch of the hob does not determine the pitch of the teeth to be cut, this being the function of the gear ratio on the machine, and a variation of hob pitch from this gear ratio only gives us a thin tooth.

#### SWIVELING THE HOB

Under the sub heading of "Swiveling the Hob," Mr. Thompson says "that owing to the backing off of the teeth we are reducing the diameter of the hob every time we grind it, and so, strictly speaking, we should *increase the angle* to which the hob is swiveled after each grinding." Now this is contrary to facts, for if we reduce the diameter, and the lead of the spiral remains the same, the angle will be smaller, therefore the setting angle should be *decreased*.

#### ACTION OF THE TEETH OF A HOB

Under the subheading "Action of the Teeth of the Hob," Mr. Thompson says that I make a curious mistake when I assert that, with hobs in which the spiral grooves are cut normal to the thread the teeth come into action a fraction of time behind each other. Mr. Thompson is making the mistake, and he can prove it by laying a straight-edge along the face of the teeth of such a hob and he will see how impossible it is that they should all come into action simultaneously.

As a further proof I present a diagram. The rectangle represents the hob, the line *A A* being the axis; *B B* represents the setting angle, and a line *C C* drawn parallel to *B B* shows when the first tooth would come into action. The curved line is a trace on which all the tips of the hob teeth would lie, and it can be seen that my statement was correct. If on the other hand the grooves are straight and along the line representing the axis, then if the hob is not swiveled this line would also represent the face of the work, and all the teeth would naturally come into action together. Mr. Thompson has not satisfied me on the point I raised *re* the accuracy of the built-up hob relative to the accuracy of a carefully made solid hob by a good toolmaker. Grinding up the teeth is all very well but we must consider that not only are the blades turned end for end after grinding, but they are put into different slots; consequently the whole accuracy of such a hob depends on the accuracy of the slots into which the blades are placed, and, incidentally on the method of fastening them in. If, as I said in my previous letter, this accuracy

can be guaranteed, then I am prepared to admit there *may* be a use for the hob on large pitches.

Under the question of flats Mr. Thompson says, "that the finishing hob was designed with a large number of blades so as to increase the number of plotting points." How he can increase the number of plotting points by increasing the diameter of the hob I fail to see. Let us take a case: Suppose we have a finishing hob 6 inches diameter with inserted teeth, and a solid finishing hob 3 inches diameter. Being of the same steel, they must run at the same cutting speed; consequently the ratio of their revolutions would be as 1 to 2, and as it is impossible to insert blades and still keep the pitch of the teeth as small as in the solid hob (that is, for a given strength), it follows that by increasing the diameter and inserting the blades he has really decreased the number of his plotting points.

In the early part of the general introduction of the hobbing process it is within my recollection that a straight-sided, straight-grooved hob was tried without swiveling, and the hardness of contact at the tips of the generated teeth was more noticeable than with a hob as made today. There is one possible explanation of this hardness that is perhaps not generally recognized; no matter how keen a hob is, there is a tendency to spring away on the part of the work, and this spring would be more at the tips than at the pitch line, and, as the ratio between the addendum and the radius of the gears differs, so we get a more pronounced hardness on the pinion. In conclusion, I don't think the future of the hob lies with inserted teeth, but rather with a more careful manipulation of the steel during manufacture of the solid type, and much can be done in the early stages of manufacture, to insure accuracy, by roughing out the hob all over, gashes included, and then thoroughly annealing after previous hardening and before finishing is commenced. This is not generally done, but it pays, and the extra cost is small.

WALTER G. GROOCOCK.

Woolwich, England.

## How Hot is Fairly Hot?

In an article on annealing high-speed steel a contributor suggests heating up the annealing box until fairly hot. I'm sure it would be useful and instructive to a lot of readers if this degree of temperature could be marked in plain letters (for it looks as though we are to understand temperature by terms of word rather than numerical quantities in degrees) on the dial of our pyrometers if its location can be proved with the same degree of certainty as the North Pole since the advent of Cook and Peary; if this can't be done then let us adhere to the old-time custom of stating temperature in figures if only approximately; there is surely nothing more annoying than this indefinite, or may be purposely evasive, method of giving information.

Some day I hope we shall learn to say the number of minutes in actual figures when asked the length of time to do a job in place of answering, "a bit," or "not long." I often feel tempted to ask how *long* is *long* and thereby risk my reputation as a mathematician, for I know of no formula for finding the value of this quantity, and it is marked on none of my instruments, but perhaps that's my fault.

Wilmerding, Penn. J. HAITHWAITE.

## Gas Engine Cylinders

On page 951, Volume 32, Part 1, in the editorial correspondence, mention is made of the methods of finishing automobile-engine cylinders. In the last paragraph on the page, "F. H. C." says: "All of them are a good deal nearer round and true before the engine is run than they are when it is turned into a rapid-fire gun."

There seems to be no way of determining exactly what shape the cylinder is, when the engine is running, but it is certain that some cylinders hold their shape better than others. A cylinder that shows a long black pocket in the side, has probably been far from round while running. But the error in this cylinder may not measure any greater than in one where the walls show a nice polish all around. The difference is in the character of the distortion.

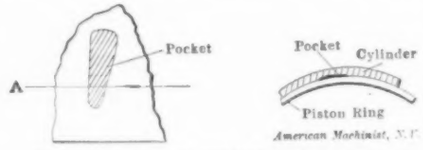



FIG. 1. PIECE OF CYLINDER SHOWING POCKET

In the first case, the curvature of the wall changed abruptly and formed a pocket or trough, Fig. 1, which the piston rings did not touch. In the second case, the hole became elliptical, but the curvature changed gradually, and the rings would follow. It must be remembered that 0.010 inch "out of roundness" in a 5-inch cylinder is only ⅕ per cent. error, and that the limit for "out of roundness" is usually not over 0.003 inch (measured cold), or, in this case, 1/15 per cent. Where the difference from a true circle is so slight, the rings will lie against the cylinder wall and prevent leakage.

Lugs and ribs on the outside of the cylinder will affect the shape of the bored hole, while a cylinder that is a plain tube is more likely to retain a round hole at high temperature, other things being equal.

In order to have a good cylinder at high temperatures, the bore should be free from pockets while cold. As said before, the cylinder need not be absolutely round, but sudden changes in curvature should be avoided, changes such as are formed by a boring tool digging into a soft place in the iron or riding over a hard place.

It is in this respect that grinding is the best method for finishing a cylinder. The grinding wheel, held by a stiff arm and spindle, and removing but two or three thousandths on heavy cuts, and only a fraction of a thousandth on finish cuts, is not easily affected by hard or soft spots in the iron. The result is a hole which may not be absolutely round (and, in fact, seldom is), but a section of the cylinder would show a smooth curve without pockets.

Worcester, Mass. W. C. SEARLE.

## Producer Gas vs. Steam Power

The article on page 153 about the producer-gas plant of the Philadelphia Gear Works, appeals to me just now doubly because we are planning a power plant of about 50 horsepower for the new North shop. In this latitude we have to heat the shop as well as furnish power, so we have the two things to consider. Judging from past experience, it will take all the exhaust steam we can make to heat the shop when the temperature is 10 degrees. Possibly we may get a heating system that will enable us to get along without live steam in zero weather. If we put in a producer-gas plant, we will get, according to the Philadelphia Gear Works' report, a horsepower for about one-third the coal that we will buy for a steam plant; but the gas-engine exhaust contains only 2835 B.t.u. against 7020 for the steam plant, and I do not know how we can save any of the heat in the gas-engine exhaust while I do know that we have use for all of the exhaust steam a part of the time and most of it for six months in the year. The gas engine delivers to the belt 2700 B.t.u. and the steam engine only 810 per pound of coal burned, leaving a difference of 1890 heat units in favor of the gas engine. Now, again, we know that these 7020 heat units that go out of the exhaust pipe will heat our shop, but it is only a portion of the time that we need all of it, and for half the year we do not need any of it. Is it a safe guess that we will have use for over $\frac{1890}{7020}$ or nearly 27 per cent.? If it is, and I feel pretty safe about it, then on the score of fuel expense, I should prefer the steam power. In more southern latitudes, or nearer the gulf stream, I can see that the gas engine might be far preferable; and again, if it is possible to utilize the heat lost in the gas-engine exhaust for heating purposes, there might be possible a different point of view.

As for cost of labor for operation, I am inclined to think that most employers would feel that it was just as necessary

to hire an engineer for the gas-engine plant and keep him on duty all the time as for a steam plant. The gas plant is said to require stoking only every two hours. A steam plant, where the boiler is not pushed, can be run on as small a number of firings. In the South shop, our engineer has run for years without firing after 7 a.m. until 10, and then going till noon, and repeat in the afternoon. He is there for emergencies the rest of the time, for no gas engine can demand less attention than a steam engine.

The question of comparative first cost and subsequent depreciation is one that ought to be considered as well, so I would like to know from your readers how these costs have been found in practice and also what the cost is for plant and running expense for low-pressure boilers for supplementing a gas engine in latitude 40 degrees or thereabouts.

CON WISE.

Wocester, Mass.

## Inventing and Patenting

In an AMERICAN MACHINIST published a short time ago were given results from investigating whether or not certain arbitrarily chosen patents had paid their patentees. The answers received in response to questions propounded to these patentees showed a general dissatisfaction with everything connected with inventions, patents and patent law.

There are, of course, numberless reasons why nearly all of these patents were failures, but it is probably safe to say that most of them were due to one or more of the following causes: The invention was not made with any knowledge of what had been already done in its particular field; its subject matter was one for which there was no demand; or, insufficient study was given to the preparation and prosecution of the application.

### KNOWLEDGE OF THE FIELD

Lack of this important point accounts for most of the abandoned applications, amounting to 20,000 or so a year, as well as for the small value of many patents which are issued. Most patents are put in blindly and are often met by rejections on patents showing exactly the same construction and the case is then abandoned, the cost of the application being a dead loss. Often, however, the attorney is able to squeeze the patent through by dropping all claims of any value and taking one or two claims so narrow and limited that the result is a patent not worth the final fee. A reference that robs an application of its value is very often not shown to the inventor by his attorney, but his attention is called in a letter to the fact that "the Office has cited a reference in your case which will make it necessary to change certain claims, but there is no doubt that we shall be able to obtain a patent for your improvement." The right thing for his attorney to do in such a case is to send him a copy of the reference, call his attention to the fact that it anticipates the principal features of his application, and ask him if he wishes to go ahead and obtain such narrow detailed claims as may be possible. This would be on the same principle as a man who wished to build the first summer hotel at a certain place and sent an agent to buy a lot of land. If the agent found another man just starting a summer hotel there he would, if he were honest, immediately communicate the fact to his principal and give him the opportunity to drop the matter if he desired, rather than to buy a piece of land simply to secure his commission.

Professional inventors often have all the domestic and principal foreign patents at their disposal and are able to tell in advance how an application for patent will fare when it reaches the Patent Office, also whether such a patent as may be obtained therefor will infringe any other patent. Frequently a patentee finds that he cannot use the invention of his patent because it is covered by a broad claim in a patent belonging to someone else, a fact which, if he had known, might have caused him to retain the cost of his patent.

Frequently, a few dollars invested in United States patents will show an inventor just where he stands, while in another case $25 or more would be necessary. It is pretty safe to say, however, that if a large number of patents have issued in a particular line the field has been so thoroughly plowed and harrowed that it will be advisable to get the copies of patents or drop the matter.

### INVENTIONS WITHOUT A MARKET

There are men who seem to think that anything which is new must be valuable, provided it is patented so that a monopoly of that particular thing rests with the patentee. They are likely to be about as valuable as the gas stove which the farmer got for his wife. There may be cases in which the invention would make a market for itself, but introducing such an invention should be left to someone with plenty of money which he can afford to lose. The professional inventor is pretty apt to consider carefully the likelihood of a ready demand for an invention which it is proposed to patent. The question of demand may often be settled by asking if the proposed invention is either cheaper or better than holding the market. It may be both. It may be neither. Many patentees have tried to sell their patent to a manufacturer and have been told that it not only does not do the thing desired as well as that already in the market, but in addition costs more to make. When you add to this the fact that the device in the market is often the subject matter of an expired patent and can be made free of royalty, the folly of expecting to realize anything on the patent is apparent.

### WEAK PATENT SOLICITING

The inability of many patentees to enforce their patent rights and prevent manufacturers or individuals from using their inventions without compensation is very often due to the fact that their patent was so hurriedly prepared and prosecuted in the Office that it is not difficult for an interested party to find loopholes by which he may avail himself of the essence of the invention without coming under the wording of the claims. Nothing is more common than for a patentee to find that if he had secured claims as broad as he was entitled to, he could have obtained considerable for his patent. A great many patent solicitors advertise to prepare ordinary applications for patent for $25 or $30 exclusive of the Government fees. In perhaps one or two cases out of ten it is possible to do justice to the inventor at this price, while in the other eight or nine, if a profit is to be obtained, the inventor's interests must be sacrificed. This condition is largely due to the fact that the inventor thinks only of the price he is to pay instead of also considering the quality of the work he is to receive. If this same man was having a piece of work done which had got to last 17 years he would give instructions to spare no expense in the material and workmanship. A patent solicitor has office expenses to meet and is entitled to fair compensation for his time. At the popular rate for applications the amount of personal time he can give to each case is necessarily limited. If he could give several hours' or several days' more study to a particular case and rewrite and strengthen its claims as many times as seemed necessary to fully protect the invention, the additional cost to the inventor would be trivial in comparison with the additional value of the patent. It also seems inconsistent with fair business practice to charge the same price for widely varying pieces of work. The man whose patent takes but little time to prepare ought not to pay the same as another man whose patent takes much longer. One would not like to pay the man who cuts his lawn the same price his next door neighbor pays when his neighbor's lawn is twice as large.

The ordinary inventor will pay only a small price for his patent and then complains because he gets a small-price patent that anyone can go around. Real-estate men advertise a house as having been "built by the day." A patent which is built by the day is a better investment for its owner than if it were built by the job.

IRVING D. KIMBALL.

Lowell, Mass.

# AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

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Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During* 1908 *we printed and circulated* 1,205,750 *copies of the* AMERICAN MACHINIST.

*Our circulation for September,* 1909, *was (weekly, monthly and European)* 111,750.

*October* 7..... 36,250
*October* 14..... 19,000

*This paper reaches* 36,250 *separate readers each month and* 19,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*


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## Automobiles for 1910

Travelers in the public streets of any city in this country, whether large or small, cannot fail to be impressed with the fact that there seem to be more automobiles in operation each day than there were the day before. We have all been astounded at one time or another by compilations of figures showing how many machines are in use, and how many are expected to be manufactured in the future, and from these one would be forced to believe that before very long the supply of machines must equal the demand and the inevitable result of a break in prices must follow.

This, however, does not seem to be the opinion of most of the manufacturers of automobiles as determined from a canvass made by one of the officers of the American Motor Car Manufacturers' Association. From these figures it appears that the manufacturers have it in mind to eclipse all previous records of manufacture in 1910. There are at present 300 listed manufacturers of automobiles in the United States and the announcements of 80 of the principal concerns result in an estimate of very close to 200,000 new automobiles to be manufactured next year. There are at present in the United States 150,000 machines in operation, and this shows that next year the output is to exceed the total present machines in use by 33⅓ per cent. Those who have had to wait for the delivery of new machines will appreciate that this should somewhat shorten the wait, although it is quite possible that the demand will be so much greater than before that even with the increased output many buyers will have to wait for their machines as in the past.

Of these 200,000 automobiles, it is estimated that 165,000 will be driven by gasolene and for pleasure only. It is also estimated that the manufacturers of high-wheeled gasolene buggies, which are becoming so prominent, will turn out about 30,000 of these machines next year. Further than this it is estimated that there will be about 5000 other machines driven by steam and electricity and those built for commercial purposes. The average price of these machines is from $1000 to $1200. This, as the automobile purchaser knows, is without accessories, and a good average of what the buyer has to pay before his automobile is ready to run will be about $1300 or $1350. Taking $1300 as the average price, this would mean that the people of the United States expect to spend about $260,000,000 for motor vehicles in 1910. There should be no doubt that some of this $260,000,000 will be profit to the makers. It is quite well known that the extremely complicated nature of the automobile and the vast amount of experimentation and construction of special machinery for manufacture, which has been necessary, has robbed many automobile manufacturers of their legitimate profit. It is to be hoped that enough of the $260,000,000 to be spent in 1910 will stay with some of those more energetic and persistent manufacturers to pay up for some of the losses incurred in the past and give them a fair reward for their efforts.

Estimates of the number of machines made in 1909 put this at 80,000. This was the output of the factories and is only 40 per cent. of next year's contemplated product. It is said there are 55,000 automobiles in use in the State of New York at the present time, and 28,000 machines in New York City alone. During the recent Hudson-Fulton celebration a glance at the streets and boulevards would lead one to believe that every one of the 28,000 machines in New York City has been in constant use day and night during this period.

The largest output promised by any one manufacturer is 30,000 machines for 1910. These people build one of the best of the cheap grades and it is indeed a fact that the vast volume of trade is in favor of the cheaper car. Another large concern is planning to build 25,000 machines and still another 20,000. These figures might be tapered off down to the smallest builder, but it is the large figures in which we are interested. A better impression of the rate of manufacture will be gained when it is considered, that counting on 300 working days a year, it will be necessary in order to turn out 30,000 machines a year, to build 100 complete automobiles every working day. This looks as if some of the makers expect to work nights as well as daytimes, and when the vast influence of all this industry is reflected upon all the other industries for the making of parts and accessories, we can well be led to believe that the "period of depression" has passed into history for this once at least.

## Noise and Friction

The grinding of a pair of gears, the squealing of a belt, the unmistakable smell of a hot bearing and the sight of roughened wearing surfaces all tell us of losses. Note the use of the plural, losses, instead of the singular, loss.

The common thought in this connection is the loss of power, and a very great loss this is. Energy in large measure is converted into noise and heat, serving no better purpose than the oil the apprentice boy drops on the floor instead of into the oil hole.

At the same time noise and heat, instead of serving no good purpose, may serve a bad purpose, by becoming a decided source of unpleasantness to the machine operators, thus tending to lower their productive efficiency. This is a second loss, a reducing of the productive value of employees who are compelled to

have their ear drums pounded, continually pounded, by noise.

Great care is usually taken to have the offices of the shop quiet. Partitions are put around them, noisy machines are moved away and adjacent machines, pulleys, etc., are tuned up to run as quietly as possible. "The clerks cannot think if there is a distracting noise." How about their brothers in the shop? Did anyone ever suggest that a reduction of the noise there would be agreeable and tend to produce conditions less distracting? What is the difference between the ears of the man in the office and the ears of the man in the shop?

Think this over and remember that much can be done to reduce machine-shop noise if there is a will to do.

But noise and friction tell us of another loss, wear. Gear teeth that grind are wearing, and it remains to be proved that such wear improves their shape. A belt that squeals is polishing the face of its pulley and rubbing off, or burning, its own surface. A bearing that smells is roughing up or getting ready to run out its babbitt. A cut and scratched wearing surface tells of the friction that has caused this condition.

Thus the friction of a machine is a measure of its length of life, barring accidents, for it is a measure of the wear that will take place.

Of two machine tools the one that requires the least amount of power to drive its own mechanism in doing certain work is the better for at least two reasons, the cost of power lost in the machine is less and the wear is less. It has the advantage both going and coming. When you look over machine tools purposing to buy, did it ever occur to you to consider their relative merits as consumers of power, and then figure out what that power consumption really means? The day will come when such analyses will be common. Such analyses will tend to establish efficiency ratings for machine tools. And why shouldn't a machine tool have an efficiency rating as much as a boiler or engine, or dynamo?

Is not efficiency in the use of power as important as efficiency in the generation of power? Could not standard specifications be prepared to test machine tools just as well as to test steam engines?

Heretofore we have said that noise and friction produce *losses*. This is true from the standpoint of the individual, but from a broader viewpoint unnecessary noise and friction are *wastes;* wastes of power, human energy, machine parts and ultimately money for untimely repairs. Their reduction is a real way to conserve resources.

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Imports into the United States from the Philippine Islands under the new tariff show an increase of more than 100 per cent. in August, 1909, when compared with August, 1908.

## Are Increased Prices of Machine Tools Impending?

The revival of prosperity in the machine-tool industry has brought with it many perplexities and machine-tool builders are already beginning to ask themselves if, under the circumstances, "prosperity" is not a misnomer for mere activity. The cost of materials is advancing and bids fair to advance still more, while the difficulty of obtaining help at prevailing wages indicates that an increase of wages may be a necessity in the near future.

It is well known to all who have compared the prices of machine tools with those of other classes of machinery on the bases of weight, quantity and quality of work, that manufacturers of machine tools undoubtedly give larger value per dollar of price than the manufacturers of any other class of machinery whatever. Those indeed who have made a critical study of these matters constantly express surprise, though, perhaps for business reasons, strictly privately and not for publication, that machine tools can be marketed at the prices which obtain. The margin of profit in that industry is undoubtedly smaller than in any other line of machinery manufacture, and any considerable increase of cost can scarcely fail to be followed by an increase of prices.

Such a result is to be deplored, especially when its effect on export business is considered, but should the situation develop, as it now promises to do, we cannot see that machine-tool makers can be justly criticized should the advance take place.

## New Publications

ALTERNATING-CURRENT MOTORS. By A. S. McAllister. Third edition. 340 6x9-inch pages; 138 illustrations; indexed. McGraw-Hill Book Company, New York City. Price, $3.

The success of the first editions of this work argues well for the third edition, for though it has been extensively revised and enlarged it has, in no sense, lost its most important and individual feature, the concise and logical arrangement. Important changes and additions have been made in order to keep it abreast of the latest developments in the theories of alternating-current motors. It now fully covers induction, synchronous and commutator motors. It treats of the essential features of the recently developed split-pole, variable-ratio synchronous converters, and brings in new material of much value, considering them both as motors and condensers. The chapter on "Prevention of Sparking in Single-phase Commutator Motors" has been greatly expanded.

## Personals*

Carl E. Hardy has been appointed assistant superintendent of shops in the manufacturing department of the U. S. Navy Yard, Mare Island, Cal.

H. B. MacFarland, consulting engineer, Chicago, Ill., has accepted a position with the Atchison, Topeka & Santa Fé Railroad Company as engineer of tests.

Edward J. Kunze, until recently consulting engineer in Newark, N. J., has become instructor in steam and gas engineering, University of Wisconsin, Madison, Wis.

Herbert L. Watson, on the engineering staff of the Allis-Chalmers Company in the Cleveland district, has been transferred to the Boston office to act as sales engineer.

Milan H. Fisher, formerly superintendent of Smith & Brush Runabout Company, has accepted the position of general manager of the Donaldson & Fisher Company, Chicago, Ill.

T. D. Weaver, formerly of the pump department of the Bethlehem Steel Company, has accepted a position with the Allentown Rolling Mills in their Aldrich pump department.

W. B. Peirce, until recently works engineer of the C. W. Hunt Company, has resigned to accept a position with the Buffalo Nut Company, North Tonawanda, N. Y., as general superintendent.

H. W. Rowley, until recently sales engineer of the New York office of the Allis-Chalmers Company, has opened an office as special representative for that company in the Evans building, Washington, D. C.

Dickerson G. Baker, who has been associated as consulting engineer with Samuel M. Green, Inc., Holyoke, Mass., has become works manager of the Blake & Knowles Steam Pump Works, East Cambridge, Mass.

Harvey L. Fisher, formerly connected with the experimental departments of the Oliver Typewriter Company and the Burroughs Adding Machine Company, has become vice-president of the Donaldson & Fisher Company, Chicago, Ill.

Robert Hughes, who for the past three years has been assistant chief rate setter for the Western Electric Company, in charge of the work at the Clinton street (Chicago) plant, has resigned and accepted a similar position with the Automatic Electric Company.

Victor Girard, one of the managers of the Berlin office of Schuchardt & Schütte, and Oskar Burghardt, general manager of their St. Petersburg branch, are at present in the country for the purpose of visiting the more prominent manufacturers in the lines handled by S. & S.

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*Items for this column are solicited.

# New Tools and Machine Shop Appliances

## Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

## THE LATEST INFORMATION

### A New Line of Cincinnati-Bickford Drills

The Cincinnati-Bickford Tool Company, Cincinnati, O., has redesigned its line of upright drilling machines, and some of these are illustrated herewith. Figs. 1 and 2 show their 20-inch sensitive drill, the first showing a special table construction, which will be found extremely convenient in some classes of work. The combination of the swinging arm and the revolving table enables the operator to bring any point of the work under the drill very easily. The balancing of the spindle and sliding head is somewhat unusual, and the table arm and lower sliding head are clamped to the column by the movement of one lever. The regular table is shown in Fig. 2, as is the power feed and the method of mounting a motor, which differs from the ordinary construction. The spindle sleeve is graduated in inches and has an automatic stop for tripping when the drill has reached the desired depth. All gears are guarded, and the question of design and the distribution of metal has had careful attention. The spindle is 1 3/16 inches in the sleeve and 6 3/16 inches traverse. It is bored to a No. 2 Morse taper and will handle drills up to ¾ inch at the fastest speed, and larger if the feeds are slowed down.

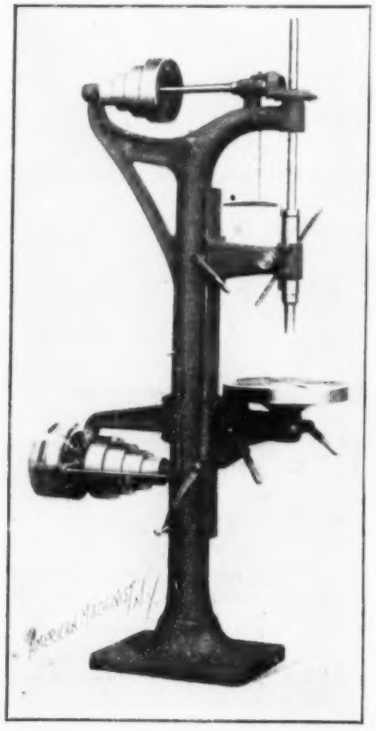


FIG. 1. 20-INCH SENSITIVE DRILL WITH SWINGING TABLE

FIG. 2. WITH MOTOR MOUNTED AT THE BACK

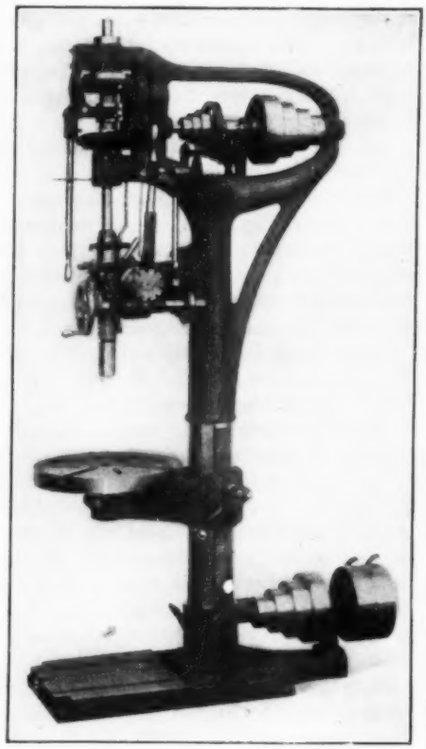


FIG. 3. STATIONARY HEAD, 21-INCH MACHINE

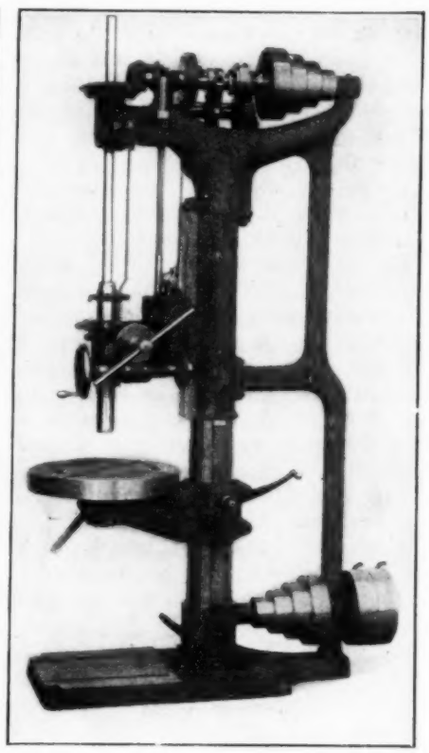


FIG. 4. SLIDING HEAD AND TAPPING ATTACHMENT

In Fig. 3 is seen the 21-inch machine with stationary head, and also the new tapping attachment. This is a very heavily built machine, and back geared, the back gears being operated by a clutch controlled by a lever on the other side of the collar. This has a lever feed and a latch to allow the lever to be changed to its most convenient position, and power feed is provided by the cone pulleys, worm and bevel gearing shown. The table is unusually heavy, and can be had either round or square as preferred. The bevel gears are all planed to insure quiet running and long life, and similar care has been taken in the construction of all the vital points.

The tapping attachment is of their new design and now has a return ratio of 1½ to 1. It is very easily controlled, positively locked in any position, and can be completely disengaged when no tapping is to be done, which has many advantages.

Fig. 4 shows the same size machine, with a sliding head, making it extremely convenient and of a large capacity. The head has a movement of 17½ inches, and the table 16¾ inches, while the spindle has a 9-inch traverse. Friction back gears are provided, and can be thrown in or out

of action without stopping the machine. This machine also has an all-geared feed, which can be seen on the sliding head near the collar. Turning the handle shown gives four different positive feeds, clearly indexed in thousandths of an inch per revolution of the spindle, so that the operator can see at a glance exactly what the machine is doing. The automatic trip is provided the same as on the other machine, and such details as ball-thrust bearings and jamb nuts have been carefully looked after. This allows facing and undercutting to be done with perfect safety. The middle position of the back-gear lever acts as a stop to the spindle, which is very convenient in many cases. When it is desired to run the spindle at high speed, the back gears can be entirely disconnected so that the upper shaft runs perfectly free. The friction back gears are particularly useful in allowing the drill spindle to be stopped for changing chucks or drills without stopping the whole machine and is an improvement that will be generally appreciated. Although Fig. 4 is shown without a tapping attachment, they are furnished the same as in Fig. 3 when desired, and have the same advantages in either case.

These same improvements in design and construction have been carried through all of their line of upright drills from 24 to 42 in., all now being made from entirely new patterns, making a very complete line of drilling machines designed and built along modern lines to handle high-speed drills to their best advantage.

## Ransom Disk Grinder

This machine has been designed especially for automobile work, such as facing gear cases, exhaust manifolds and similar pieces. It is very heavily built in every way, being driven with a 10-inch belt. The tables are supported by three-inch machine steel bars, so as to handle heavy work without springing, and the tables can be adjusted so as to be perfectly square with the grinding disk, which is essential on many classes of work.

Steel disks, either 23 or 27 inches in diameter can be used, and instead of being secured by countersunk screws, bolts and nuts are used as being less liable to work loose. Both tables have lever feed so that two operators can work at the same time, the belt having power enough to carry any load that may be put on it in this way. Both tables can be tilted to 45 degrees with the face of the disk, they can be raised and lowered and the oscillating sleeve can be clamped rigidly to the arm.

Fig. 2 shows a machine or clamp for renewing the grinding disk. The grinding circle is placed face down on the table of the machine and covered with cement. Then the steel disk is placed on the central arbor as shown, and lowered into place by the crank handle at the side, so that it is very easy to have everything central. The side clamp carries a stud for holding a fit conveniently while removing the worn out abrasive. These are made by the Ransom Manufacturing Company, Oshkosh, Wis.

## A Breast Drill

The halftones, Figs. 1 and 2, show a breast drill which has recently been brought out by the North Brothers Manufacturing Company, Philadelphia, Penn.

This little tool is well made and many unique features are incorporated in its construction. Fig. 2 shows the breast drill assembled. Two speeds, a high and a low, are available, either of which can be obtained instantly even when the drill is in motion by swinging the small lever *A*. With the lever in the position shown the slow speed is in operation, but swinging it to the right engages the high speed. The sliding button *B* controls mechanism concealed in the barrel between the two central bevel pinions. When opposite the slot marked 1 the tool is ready for use as a regular breast drill; when opposite the

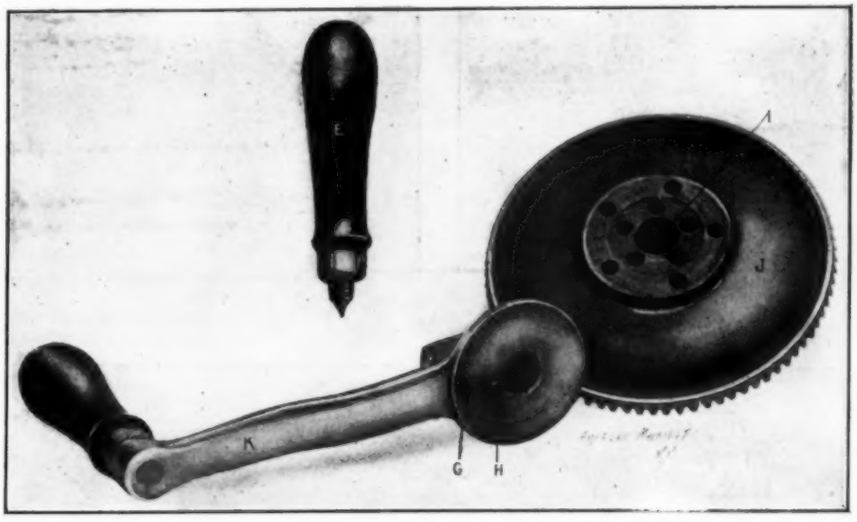



FIG. 1. THE SCREWDRIVER HANDLE AND GEAR CLUTCH

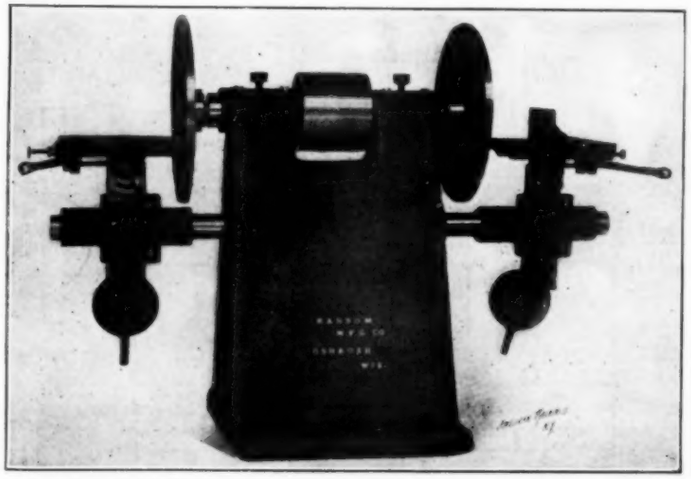


FIG. 1. 27-INCH DISK GRINDER

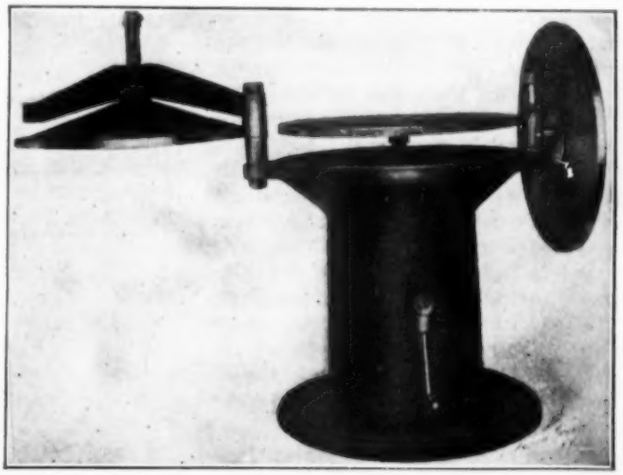


FIG. 2. DISK CLAMP FOR 27-INCH GRINDER

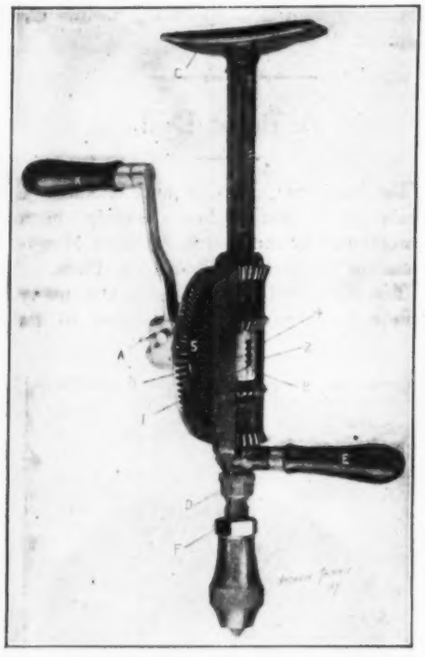


FIG. 2. A BREAST DRILL

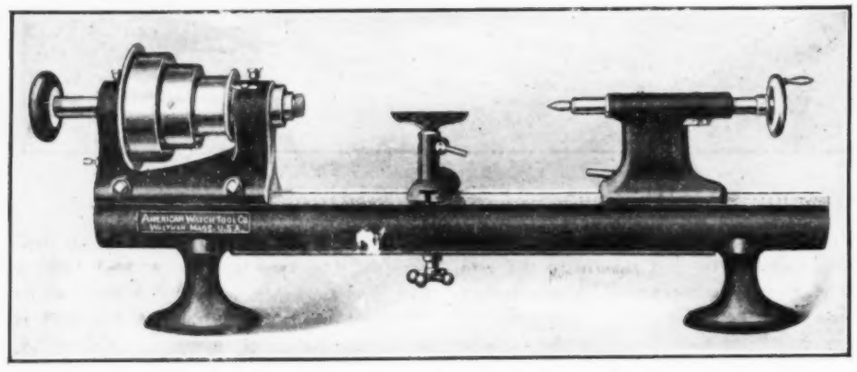


FIG. 1. PRECISION BENCH LATHE OF AMERICAN WATCH TOOL COMPANY

slot marked 2 the tool becomes a left-hand ratchet brace; when opposite the slot marked 3 it becomes a right-hand ratchet brace. When opposite 4 it becomes a double right-hand ratchet, both the forward and backward motions of the handle *K* turning the drill in a right-hand direction; with the button *B* opposite the slot marked 5 the gears are locked so that the spindle carrying the chuck is immovable; this facilitates tightening or loosening the chuck. It will be noted that the chuck is not only provided with a nurled sleeve for the hand, but with a hexagon for a wrench.

The pad *C* is secured to the shank by a screw and it can be swung around and secured in any position to suit the operator. The handle *E* screws into the frame and the end of the screw is flattened off to form a screwdriver which fits all the screws in the tool, making it self-contained. The thrust of drilling is taken by the ball thrust *D*.

Fig. 1 at *E* shows the screwdriver handle. At *G* and *H* are shown the driving pins operated by the lever *A*, Fig. 2, which engage in the holes in the high and low gears *J* and *I*.

## Three Interesting Small Machines

This lathe has a number of very interesting features, particularly in the new headstock which is shown in several of the illustrations. The growing use of this type of lathe in modern tool rooms makes details of special interest to the toolmaker and model maker. The general appearance of the lathe can be seen in Fig. 1, while Figs. 2 and 3 show end view of both headstock and tailstock. The graduations on the front end of the cone correspond with the index holes at the back, making it unnecessary for the operator to go to the head of the lathe to set the index.

The special feature of this lathe, however, is to be seen in Fig. 4, which shows the straight bearing spindle, the split taper bearing and the end-adjusting sleeve for taking up the end thrust and wear. The bearing *B* is held in the bushing *A* and adjusted by the nut *C*, which forces it in to take up the wear. The bushing *A* is clamped into the headstock by the binding

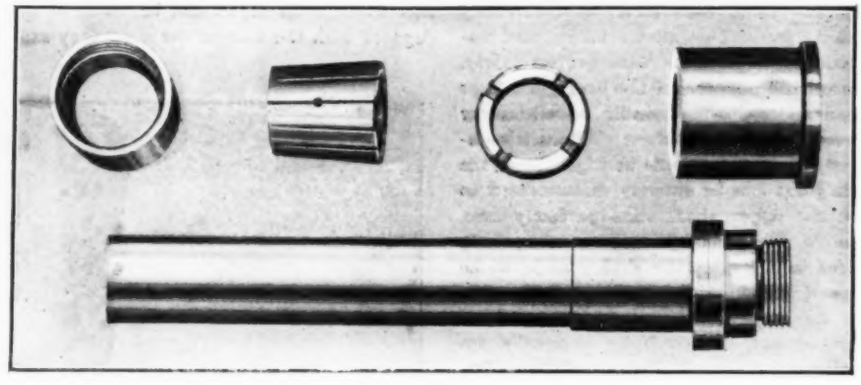


FIG. 4. CONSTRUCTION OF SPINDLES AND BEARINGS

FIG. 2. HEADSTOCK

FIG. 3. TAILSTOCK, END VIEW

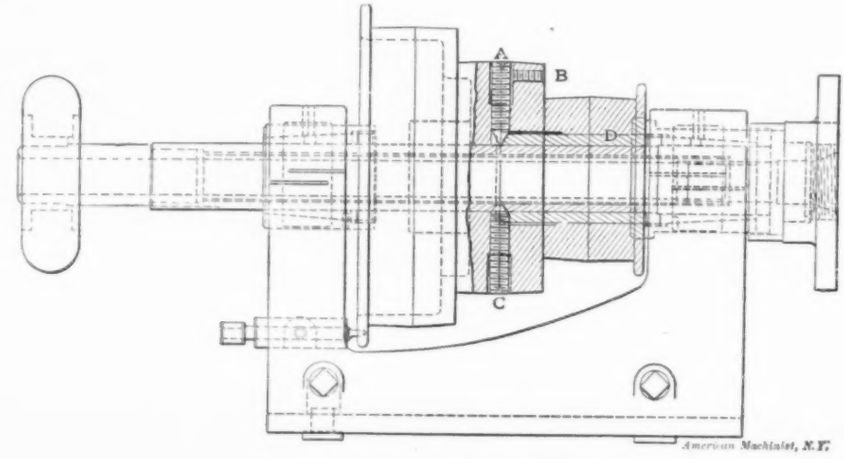



FIG. 5. HEADSTOCK CONSTRUCTION

screws shown at the right in Fig. 2, in connection with a novel method of splitting the casting. This can be seen in more detail in Fig. 5, where it will be noted that there are two slots, neither one extending the whole length of the bearing. This maintains better alinement, and at the same time gives a very powerful grip on the bearing bushings. This construction enables the entire spindle to be readily removed by taking out the draw-in tube at the back and loosening the cone-pulley screw *C*, shown in Fig. 5. This can be done without disturbing the adjustment of the end-thrust bushing *D*, which depends upon the cone-pointed screw *A*.

Fig. 5 has a section of the cone broken away. This shows the hollow spindle, the draw-in tube and chuck, the screw *C* which locks the cone to the spindle, and the way in which the sleeve *D* is adjusted against the back end of the front bearing, taking up end motion at that point and leaving the spindle free in the rear bearing. This also shows the way in which the bearing shells are clamped and the indexing pin at the back. These illustrations show one of their No. 3½ lathes, which has a bed 36 inches long, swings 8½ inches and has a chuck capacity of 5/8 inch. It is furnished with the usual bench-lathe attachments.

### Wall Countershaft

Fig. 6 shows a wall countershaft mounted on rods held in brackets, which can be arranged in almost any combination desired. The one shown is for giving two speeds, but they can also be arranged to give three speeds when desired. These can be either forward or backward, or in any combination. The rods are 1 inch in diameter and held at 4-inch centers, making a very rigid support, and yet not materially interfering with the light when they are placed across windows, as is frequently done to secure the best light on the work in the lathe.

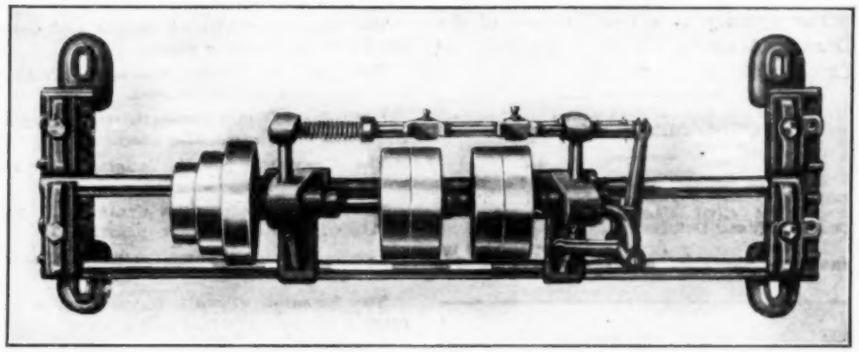


FIG. 6. WALL ROD COUNTERSHAFT FOR TWO SPEEDS

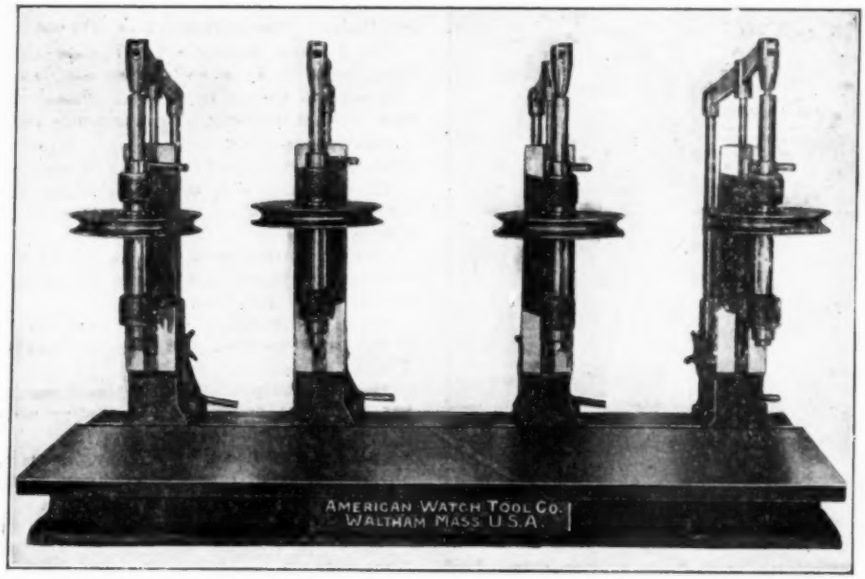



FIG. 7. FOUR-SPINDLE DRILL

### Four-spindle Drill

Fig. 7 shows a four-spindle drill mounted on a single cast-iron base and adjustable to any desired position along this base. Each spindle takes standard drill chucks and is operated by a foot treadle on the floor. It is arranged with two countershafts, either on the bench behind the drill, or on the wall. These can be furnished in any combination desired and in beds varying from 10 to 23 inches in length. They are very convenient and very rapid on light work.

### Profiling Machine

Fig. 8 shows a bench profiling machine, having a vertical spindle, and the guide located beside it. The lever at the left gives a 4-inch movement to the lower slide, while the upper handle controls both the side movement along the cross-rail and also the vertical movement of the slide carrying the spindle. This vertical movement is 1 inch, and the cross-movement 1⅞ inches, making it extremely convenient on small profiling work.

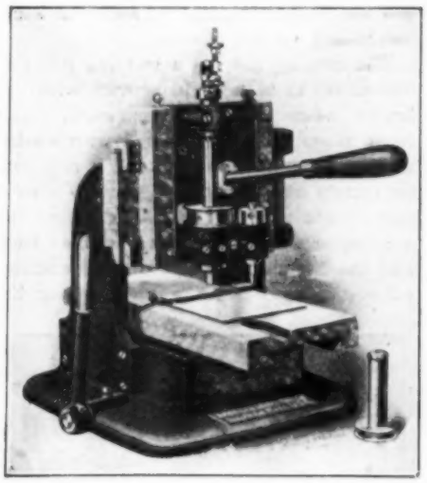


FIG. 8. BENCH PROFILING MACHINE

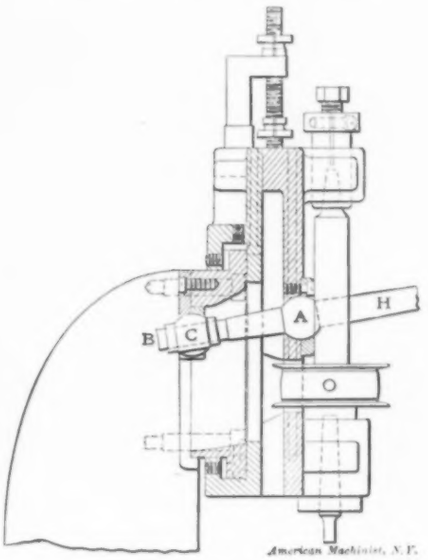


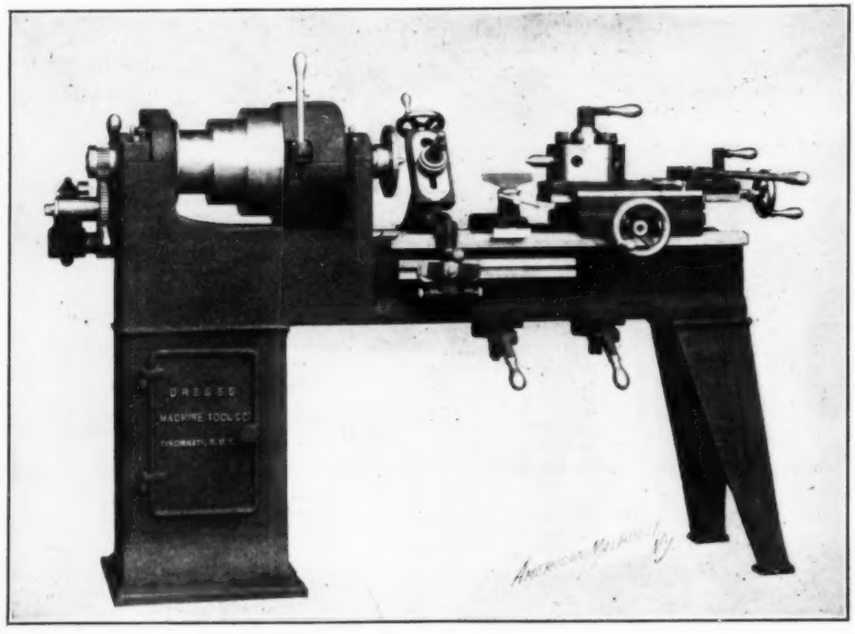

FIG. 9. PROFILING MACHINE CONSTRUCTION

Fig. 9 shows the way in which the same handle controls both movements of the milling spindle, the handle *H* having a spherical section at *A*, and the end *B* sliding through the ball sleeve *C*. This also shows the construction of the milling spindle, the gibbing of the cross slide and the operation of the stock. These tools are all made by the American Watch Tool Company, Waltham, Mass.

## Sixteen-inch Universal Monitor Lathe

The head and bed of this machine are cast in one piece and the friction back gearing is entirely inclosed. The spindle bearings are of genuine babbitt metal which are most serviceable for high-speed and lighter work, such as is done on brass-working lathes. The friction in the head is of the toggle-joint type and is so designed that the entire operating mechanism can be put in place or removed without taking out the spindle.

The chasing bar has a yielding follower holder so as to keep in contact with the leader when chasing taper work. The taper attachment is provided with nurled screws for minute adjustment. It is placed separately on the bed below the V's so it can be left undisturbed and is out of the way when the chasing head is tilted back and the hand rest, a slide rest or cutting-off rest is used. The gear connection between the leader stud and spindle is made by tumbler gearing so that right- and left-hand threads can be chased without changing the leader and follower.




16-INCH UNIVERSAL MONITOR LATHE

As the name indicates, the turret slides are provided with setover and swivel. The latter is graduated in degrees on the saddle carrying the top slide, and the former on the cross-feed hand-wheel hub. The top slide has combined lever and screw feed and the change from one to the other is quickly made by tightening or loosening the horizontal handle shown at the rear of the top slide. All slides have taper adjusting gibs. The turret is locked by a gibbed square key and both the index ring in the turret and key are hardened.

In returning the top slide, the locking key withdraws automatically and the operator uses his left hand for revolving the turret. This feature works just as quickly as an automatic arrangement and avoids a complicated lever and trigger mechanism necessary for an automatic revolving movement.

The bed is supported at the head end by a cabinet leg having several wooden shelves and serves as a tool receptacle. The tail-end leg is attached in a hinged manner so that the machine is supported on the three-point principle and cannot be thrown out of alinement or the bed be twisted when bolted to the foundation or floor.

The machine is a new product of the Dreses Machine Tool Company of Cincinnati.

## Forthcoming Meetings

American Society of Mechanical Engineers, monthly Boston meeting, jointly with Boston Society of Civil Engineers, Chipman hall, Boston, Mass., October 20.

National Society for the Promotion of Industrial Education, annual convention, December 1, 2 and 3, Milwaukee, Wis. J. C. Monaghan, secretary, 20 West Forty-fourth street, New York City.

American Society of Mechanical Engineers, annual meeting, New York City, December 7-10. Calvin W. Rice, secretary, United Engineering building, New York City.

## Business Items

The name of the Rockford Machine and Shuttle Company, Rockford, Ill., makers of drills, bench lathes, etc., has been changed to Rockford Lathe and Tool Company.

The Hill Clutch Company, of Cleveland, Ohio, announce the appointment of G. W. Hoffman, as sales engineer in charge of its Chicago office, which is located at 610 Marquette building.

Lakeside Forge and Wrench Company has acquired the plant of the Springfield Drop Forge Company, Springfield, Mass. Eugene Childs, formerly connected with Trimont Manufacturing Company, is president and general manager.

## Business Opportunities

The Marinette (Wis.) Knitting Mill will erect a new plant.

The Unity (Wis.) Cheese and Butter Company will erect a plant.

Dubuque (Iowa) Packing Company will erect a $50,000 addition.

Chandler & Price, Cleveland, Ohio, will build a new power house.

Charles Allender, Big Stone, S. D., will erect a motor-boat factory.

The Menominee (Mich.) Marble and Granite Works will erect a plant.

The Harmon Harrow Company, Creston, Ia., will move to Des Moines.

L. C. Sharp, 608 Fourteenth street, Omaha, Neb., will erect a machine shop.

The Cleveland (Ohio) Tanning Company will build a two-story addition.

The Farmers Coöperative Creamery, Tagus, N. D., will build a modern plant.

The Interstate Packing Company, Winona, Wis., will erect a duplicate plant.

The Scranton (Penn.) Button Works will erect a $14,000 addition to its plant.

The Virginia & Rainey Lake Company, Virginia, Minn., will erect a new sawmill.

A new modern creamery will be built at Hebron, Wis. A. M. Ehle is interested.

The planing mill of the Suisun (Cal.) Lumber Company was burned. Loss, $12,000.

The Library Bureau Filing Cabinet Company, Ilion, N. Y., is erecting an addition.

The F. J. Greene Engineering Works, Racine, Wis., will erect a modern machine shop.

The Eureka Machine Company, Lansing, Mich., is preparing to build a factory building.

The Carpenter Steel Works, Reading, Penn., will erect an addition to its inspection building.

Cyrus Currier & Sons, Newark, N. J., will erect a new foundry to replace the present one.

The Great Northern Railway Company is to construct an additional shop at Superior, Wis.

The Waterbury (Conn.) Machine Company has had plans drawn for a four-story addition.

The Garlock Packing Company, Palmyra, N. Y., is making extensive additions to its plant.

The Ohio Steel Foundry Company, Lima, Ohio, will erect two additions to its steel plant.

The Cleveland (Ohio) Steel Company has had plans prepared for an addition to its plant.

The Safety Door Hanger Company, Ashland, Ohio, has had plans prepared for a new factory.

The carbonated water factory, owned by G. Foster, at Plainfield, Wis., was destroyed by fire.

M. L. Oberdorfer, Syracuse, N. Y., is erecting a three-story addition to his brass foundry.

The Columbia Paper Bag Company, Baltimore, Md., will erect a $15,000 addition to its plant.

Jacob Hunsicker, Reading, Penn., is erecting a large addition to his coach factory and smith shop.

The Roessler & Hasslacher Chemical Company, Perth Amboy, N. J., will enlarge its power plant.

Max Blum, Phœnix Mils, N. Y., expects to install a new engine and larger boiler in his creamery.

The Meridian (Miss.) Planing and Creosoting Company is preparing to rebuild its plant recently burned.

The Albion (Mich.) Malleable Iron Company will erect an addition to be used as a pattern room.

The Rogers Auto Company, Omaha, Neb., will erect an auto factory at Ralston, Neb., to cost $250,000.

The Knapp Water Tube Boiler Manufacturing Company, Minneapolis, Minn., is erecting a new plant.

The American Label and Manufacturing Company, Baltimore, Md., will build an addition to its plant.

The woodworking plant of the Agee Wagon Works, Eldorado, Ark., was destroyed by fire. Loss, about $15,000.

The carriage factory of S. V. Brundage & Sons, Chicago, Ill., was destroyed by fire. Loss, about $75,000.

The Prairie du Chien (Wis.) Egg Case Company will rebuild balance of plant, which was destroyed by fire.

C. Emory Stamor, Harrisburg, Penn., is erecting a new and larger planing mill to replace the present one.

Eugene Ondin, L'Isle-sur-le-Doubs, France, desires quotations on bolt and nut machinery and slitting machines.

The Wisconsin Foundry Company, Milwaukee, Wis., has taken out a permit for erection of a pattern shop.

The Buckeye Traction Ditcher Company, Findlay, Ohio, will erect a new plant, doubling its present capacity.

The H. Bridgeman Smith Company, Brooklyn, N. Y., manufacturing paper boxes, is erecting a 12-story addition.

McFee & Borst, Oneonta, N. Y., operating woodworking mill, expect to replace present boiler with one of larger size.

The Best Foundry Company, of Cleveland, Ohio, has awarded contract for construction of a foundry at Bedford, Ohio.

The Collins Iron Works, Phelps, N. Y., is in the market for direct-connected generating set of about 200-light capacity.

It is reported that the Chicago, Milwaukee & St. Paul Railway Company will rebuild its old roundhouse at Racine, Wis.

Wheeler & Schebler, Indianapolis, Ind., manufacturers of carbureters, will erect a new factory to cost about $60,000.

The Sachs Company, Hartford, Conn., manufacturer of electric fuses, etc., has let contract for erection of a new plant.

The Brandt Manufacturing Company, Chisago, Minn., making compressed-air sprayers, will move its plant to Hastings, Minn.

The United States Aluminum Company, of Pittsburg, has acquired land at Clarksburg, W. Va., and will erect a $1,000,000 plant.

The Mandt Wagon Company, Stoughton, Wis., will build a $100,000 addition to its plant and 1000 more men will be employed.

The Thompson & Norris Company, Brooklyn, N. Y., manufacturing cork and corrugated goods, is erecting a 12-story addition.

The Hart-Parr Company, of Charles City, Iowa, building gasolene engines, etc., will build an addition to its plant at Aberdeen, S. D.

The North American Boiler Company, of Chicago, Ill., has let contract for the construction of a foundry building in Muskegon, Mich.

The J. W. Bodley Manufacturing Company, Staunton, Va., will erect a plant for the manufacture of lumber trucks and cane products.

The Nimmo Fence and Wire Works Company, Cincinnati, and Norwood, Ohio, has purchased site on which a new plant will be erected.

Contract has been awarded for erection of shops for the Virginian Railway, at Princeton, W. Va. H. Fernstorm, Norfolk, Va., is chief engineer.

The plants of the Granite (Utah) Planing Mill Company and the Granite Lumber Company were destroyed by fire, causing a loss of about $100,000.

The W. L. Scott Lumber Company, Norwich, N. Y., expect to replace its present engine with a 250-horsepower Corliss engine and install another boiler.

The Baltimore & Ohio Railroad has purchased land at Girard, Ohio, on which, it is said, the largest repair shops and yards on the system will be built.

A. G. Spalding & Bro., Brooklyn, N. Y., manufacturing sporting goods, are building an addition to their plant. New engines and boilers are to be installed.

The William N. Crane Company, of New York, has purchased site at Greenville, N. J., on which, it is said, a plant will be erected for the manufacture of stoves.

The Carnegie Steel Company has purchased ground between Youngstown and Girard, Ohio, and will enlarge the Ohio steel plant. $10,000,000 will be expended.

Butterfield & Co., Derby Line, Vt., manufacturing taps, dies, screw plates, reamers, etc., is installing a new power plant to consist of two suction gas-producer engines.

The Georgia Pulp and Paper Manufacturing Company, Macon, Ga., incorporated a few months ago, will shortly commence construction of a plant. Thos. N. Baker is president.

The General Brass and Tool Works, Nashville, Tenn., recently incorporated, will establish a brass foundry and machine shop for light work. John H. Lawrence is manager.

The Dewey System Refrigerator and Manufacturing Company, 506 Kiam building, Houston, Texas, a new concern, will erect a plant for the manufacture of refrigerators, mantels, furniture, etc.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., October 25, for dynamite, steel castings, steam separators, engineers' transit, etc., as per Circular No. 538.

The Warner & Swasey Company, Cleveland, Ohio, is building a large addition to its plant to consist of one-story steel and concrete buildings, to be equipped with electric cranes and other modern features.

The Rochester, Syracuse & Eastern Electric Railway Company will install six more boilers, turbine set and new pump station at its power house in Lyons, N. Y. Will install coal-conveying system later.

The Southern Iron and Equipment Company, Atlanta, Ga., will build a foundry to be operated in connection with its locomotive shops. E. P. Kern, Prudential building, is president and general manager.

Fire at the plant of the Klander-Weldon Dyeing Machine Company, Amsterdam, N. Y., destroyed the foundry, pattern shop and carpenter shop and badly damaged the machine shop. The company will rebuild.

The Board of Education, Newark, N. J., will soon let contract for a $650,000 commercial and manual training school. There will be a machine shop, molding room, sheet and art metal shop, woodworking shop, etc.

The Villinger Manufacturing Company, Williamsport, Penn., is being formed to take over the business now conducted by W. E. Villinger and enlarge plant. The product is special machinery, dies, tools and hardware specialties.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: October 19—Reamers (schedule 1769), ventilating sets (schedule 1770), chucks, drills, steel nuts (schedule 1769), air drills (schedule 1771), brass rivets, rod brass, sheet brass, brass tubing (schedule 1765), machine steel, cold-rolled steel (schedule 1766), nickel steel, steel tubing (schedule 1768); October 26—Engine lathe, pipe machine, drilling machine (schedule 1780), gap lathe (schedule 1781).

## New Incorporations

Fort Lupton Utilities Company, Fort Lupton, Colo. Light, heat and power plant. Capital, $30,000. D. L. Rich, president.

A. L. Milentz, Glass Cutting Machine Company, St. Louis, Mo. Capital, $20,000. Incorporators, A. L. Milentz, F. W. Schaab, C. H. Prior.

International Electrical Manufacturing Company, Portland, Me. Manufacture electrical machinery. Capital, $1,000,000. C. E. Eaton, president.

Indiana Radiator Company, Walkerton, Ind. Manufacture radiators. Capital, $30,000. Incorporators, D. W. Place, Timothy Holland, B. L. Williams, etc.

C. B. Brokâw Auto Company, Plainfield, N. J. Manufacture automobiles, etc. Capital, $20,000. Incorporators, C. B. Brokaw, A. F. Brokaw, W. B. Hopping.

The Stone Straw Company, Plainfield, N. J. Manufacture paper tubes and tubing. Capital, $300,000. Incorporators, L. L. Gilbert, H. N. Wessel, A. B. Cheadle.

# Want Advertisements

*Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.*

## Miscellaneous Wants

Caliper catalog free. E. G. Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Fine, experimental work and tool designing and making a specialty. Benj. O. Butler, Taunton, Mass.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emery & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—Two second-hand Grant-Lees worm gear hobbing machines in first-class condition; state how old and lowest prices. Box 770, AMERICAN MACHINIST.

Wanted—Purchaser for No. 2 Farwell milling machine, Grant hobbing machine and Gisholt tool grinder; all practically new and in A-1 condition. Box 755, AMER. MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Machinists and engineers blueprint chart of United States Standard pipes and tapping sizes from ⅛" to 10" pipe. Price 10 cents per copy postpaid. Liberal discounts to shop agents. Address Charles Kuderer, Woodlawn, Penn.

Aëroplane—Mechanical engineer of wide experience desires to communicate with manufacturer interested in aeronautics and willing to undertake the building of an "aëroplane," possessing great merit; metallic construction, automatic equilibrium, greater speeds and lifting power. Investigation invited. Address P. F. M., care AMERICAN MACHINIST.

## Situations Wanted

*Classification indicates present address of advertiser, nothing else.*

CONNECTICUT

Foreman of exceptional mechanical and executive ability, desires position as assistant superintendent or department manager; thoroughly versed in systematic methods of manufacturing; a designer and inventor of tools for interchangeable parts. "Mechanic," 208 Trumbull St., Hartford, Conn.

ILLINOIS

Wanted—Position as mechanical draftsman or assistant superintendent; have had four years' experience in designing and detailing of special, paint, automatic can-making machinery and gearing; have also had four years' of general machine-shop experience and have also been in charge; references. Box 782, AMERICAN MACHINIST.

MASSACHUSETTS

Production engineer for shop manufacturing valves fittings and piping; wide experience in designing, increasing production and reducing costs; can show results. Box 745, AMERICAN MACHINIST.

NEW JERSEY

Mechanical engineer desires position; experience in power plant design and installation; best of references. Box 771, AM. MA.

Mechanical draftsman; technical graduate, with five years' experience on general machinery, printing presses and automatic machines. Box 763, AMERICAN MACHINIST.

Mechanical engineer, chief draftsman and designer, experienced on pumping machinery and steam engineering, is open for responsible position. Box 714, AMER. MACHINIST.

NEW YORK

Draftsman engineer, mechanical and structural steel designer; 10 years' experience; A-1 references; particulars. Box 767, AM. M.

Wanted—By expert machinery salesman, position on the road; 12 years' experience; woodworking machine and machine tools. Box 779, AMERICAN MACHINIST.

Young man, age 32; good mechanic and executive, tool and instrument maker, desires responsible position; good on estimates; method, system; any location. Box 777, AMERICAN MACHINIST.

OHIO

Works manager or general superintendent invites correspondence from reliable concerns wishing to secure the services of a high-class executive with a clean-cut record as an earning power. Address Box 753, AMER. MACH.

## Help Wanted

*Classification indicates present address of advertiser, nothing else.*

CANADA

Thoroughly competent young man, with mechanical and executive experience, to take an interest with a view of purchasing a fully equipped machine shop, located in large city in Western Washington; plant is in operation, making gasolene engines, canning and saw-mill machiery, besides doing general jobbing work; splendid opportunity for the right man, with a few thousand dollars, anxious to acquire a business for himself, that will be a money maker from the start. Answer stating age, nationality, experience and references. Answers will be treated confidentially. Box 700, AMERICAN MACHINIST.

CONNECTICUT

Wanted—A first-class toolmaker on jig and fixture work. Box 621, AMER. MACHINIST.

Wanted—Draftsmen who have had experience in designing jigs and fixtures, especially for gun work; can get favorable position. Address Box 772, AMERICAN MACHINIST.

Wanted—In a large New England manufacturing plant, an experienced millwright and carpenter, familiar with heavy work, to act as foreman of carpenter's shop (about twelve carpenters) and to take charge of all repairs and the erection of new buildings and machinery. Address "F," AMER. MACH.

DELAWARE

Wanted—In addition to our present force, a few filers, assemblers, milling machine and profile operators on high-grade firearms; our factory and equipment are strictly up-to-date and to satisfactory workmen we can offer steady employment. In replying, please give age, experience and wages expected. Box 750, AMERICAN MACHINIST.

ILLINOIS

Man wanted, experienced in running large radial drills on heavy work. Box 708, AM. M.

INDIANA

Two experienced foremen for machine and assembling rooms, manufacturing gasolene motors. Give reference, experience and age. Box 262, AMERICAN MACHINIST.

Wanted—Machinists, five filers and fitters, five lathe men and three patternmakers to work on radiator patterns. Address, The Logansport Radiator Equipment Co., Logansport, Indiana.

MASSACHUSETTS

Wanted—Sheet steel salesman for New England territory; good position for young man who has thorough knowledge of various qualities and finishes of soft steel sheets and strips. Address Wheelock, Lovejoy & Co., Boston, Mass.

Mechanical draftsman wanted for 6 months; one with experience on several different kinds of machines and capable of working out ideas quickly and accurately; man under 40 preferred, who has had shop training; salary, $25 a week. Box 780, AMERICAN MACHINIST.

Wanted—Applications from erectors, layout men, production men, brass finishers, machine and hand molders, and operators for lathe, planer, drill, turret machines, boring mill, etc.; heavy and light work. Address Dept. 54, Blake & Knowles Steam Pump Works, East Cambridge, Mass.

MICHIGAN

Two first-class gear men wanted for day or night work; state age, experience and wages. Buick Motor Co., Flint, Mich.

Wanted—A first-class Potter & Johnston operator, to take charge of our Potter & Johnston department, nights. Box 739, AM. MA.

Wanted—Men with first-class experience on Brown & Sharpe and Acme automatic screw machine; none but first-class men need apply. Box 740, AMERICAN MACHINIST.

Experienced draftsman, familiar with ice machine and refrigerating work; give full particulars regarding age, experience and references; also state how soon available. Box 744, AMERICAN MACHINIST.

Wanted—A first-class lathe hand; must be thoroughly familiar with the Lodge & Shipley patent headstock lathe and capable of instructing operators; state experience, age and wages expected. Apply Buick Motor Co., Flint, Mich.

Wanted—An expert screw-machine operator to take the position of assistant foreman in a department of about fifty machines consisting of Jones & Lamson's, Acme automatic, Gridley and Cleveland automatic. Box 775, AMERICAN MACHINIST.

Wanted—Man to take charge of tool crib; must thoroughly understand the most up-to-date systems for keeping tools and checking; only applications from thoroughly first-class reliable men will be considered; give full particulars of experience, references, age and wages expected. Apply Buick Motor Co., Flint, Mich.

Wanted—Pattern shop foreman; by one of the large up-to-date automobile factories in the middle West; a man who is thoroughly versed in both wood and metal; also gated, plate, rockover, striping plate and other molding machine patterns; must be a man who is temperate, of good principles, and has had a large experience; an excellent position for the right man; state age, experience, present employer, salary wanted and full details; communications strictly confidential. Box 781, AMERICAN MACHINIST.

MISSOURI

Foreman diemaker, experienced on sheet metal dies of all descriptions. Swaine Co., St. Louis, Mo.

Draftsman—Wanted, young man thoroughly posted in designing and drawing presses, dies and sheet metal tools. Swaine Co., St. Louis, Mo.

NEW HAMPSHIRE

Wanted—A first-class machinist for setting up and assembling machine tools; opportunity for advancement to man with experience on similar work and capable of handling men; give age, experience and wages expected. Box 743, AMERICAN MACHINIST.

NEW JERSEY

Wanted—First-class machinists; no labor troubles. Box 768, AMERICAN MACHINIST.

Wanted—A first-class operator on Brown & Sharpe automatic screw machine. Box 773, AMERICAN MACHINIST.

NEW YORK

Wanted—Experienced draftsmen; state age, experience and wages expected. Box 757, AMERICAN MACHINIST.

Draftsman wanted; experienced with gas and gasolene engines. Room 1620, 165 Broadway, New York City. Don't write, call.

Wanted—Automatic screw machine hands; must be familiar with Brown & Sharpe machines. Apply 333 State St., Camera Works, E. K. Co., Rochester, N. Y.

Wanted—A few experienced mechanical draftsmen. Apply Engineer in Charge, Drafting Department, General Electric Co., Schenectady, N. Y., giving experience, age and salary expected.

Toolmakers wanted; first-class men experienced on jigs, fixtures and fine gages for close small work. State age, experience in detail, and wages expected. Remington Arms Company, Ilion, N. Y.

Wanted—By automobile manufacturer, five first-class draftsmen; state where at present employed, experience, age, salary and how soon you could report for work. Box 746, AMERICAN MACHINIST.

Wanted—Machinists, toolmakers, lathe hands, screw-machine hands, milling-machine hands and motor assemblers; steady position to desirable characters. Maxwell-Briscoe Motor Co., Tarrytown, N. Y.

Expert temperer, to take charge of hardening room of large factory; must be familiar with both high-speed and carbon steel; applicants will kindly give full particulars of the experience, positions held and salary expected. Box 756, AMERICAN MACHINIST.

Wanted—A young man in a machine tool sales department in New York; must be an efficient stenographer and have some knowledge of mechanical terms; a good position for a technical man who desires advancement in the mechanical branch of the business. Box 776, AMERICAN MACHINIST.

Lathe, planer and boring mill hands wanted for day and night shift; no labor troubles, increasing force; applicants must state wages desired, past experience, if employed at present, and the names of past employers, to receive further consideration. Application considered confidentially. Apply Ingersoll-Rand Co., Painted Post, N. Y.

Wanted—General foreman for large manufacturing plant building a line of sheet metal auto bodies and frames; must be a man who is now employed and is holding a similar position; must be aggressive and be able to produce the very best results; no other need apply. Address by letter only, "Sheet Metal," Care Seaman, 30 W. 33d St., New York City.

Wanted—Assistant general foreman of machine shop for large automobile concern employing 1200 hands; applicant must be man who has held similar position and able to handle men and tools to produce results; do not apply unless you are employed and able to furnish first-class reference, stating salary. Address by mail only, "Assistant Foreman," care Seaman, 34 West Thirty-third street, New York City.

OHIO

Machinist. 201 Nicholas Bldg., Toledo, O.

Wanted—Manager, who can obtain some capital, for modern machine works, running day and night, located in Ohio. "Engineers," Box 759, AMERICAN MACHINIST.

Foreman wanted for gray iron foundry employing about 100 men; piece work; open shop and no labor trouble of any description; state age and experience. Address Box 758, AMERICAN MACHINIST.

Wanted—First-class lathe, shaper and boring mill men accustomed to accurate work, for day and night shift; state age, experience and wages expected; no labor trouble; increasing force. The Heisler Company, St. Marys, Ohio.

Wanted—A man as general foreman and assistant to superintendent with a large manufacturing company; must possess good mechanical, executive and hustling ability; locomotive experience preferred; state age and experience. Box 778, AMERICAN MACHINIST.

Wanted — First-class machinists, lathe, planer, drill press, screw machine, boring and milling machine operators, die sinkers and patternmakers who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Building, Cleveland, O.

Superintendent: Progressive manufacturers having foundry, pattern and machine shops employing 500 men, need a thoroughly experienced and systematic superintendent; machine shop training essential; foundry experience preferred; give full details, past and present record, naming employers; communications strictly confidential; only men with

a record need apply; location, Ohio. Box 688, AMERICAN MACHINIST.

PENNSYLVANIA

Tool and diemakers wanted; first-class men experienced on jig fixture and die work for small interchangeable parts. Box 774, AM. M.

Wanted—Draftsmen; large company requires at once, men familiar with general engineering work; prefer those familiar with mining plants and machinery. Address Box 769, AMERICAN MACHINIST.

Instructor in mechanical drawing; a Philadelphia institution has a vacancy for a college graduate in engineering; applicant must have some drawing-office experience, teaching experience not necessary, and be a good disciplinarian; state age, education, experience, with references and submit sample print; state salary expected. Box 724, AM. MACH.

Wanted—A good live agent in every shop or factory in the U. S. to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and above his regular salary. This is no fake. Write for free sample and agents' terms. The Kienzola Co., Erie, Pa.

WISCONSIN

Wanted—Good mechanical designers and detail draftsmen for machinery manufacturer located in Wisconsin. Box 564, AMER. MACH.

# For Sale

For Sale—Morse Plain Grinder No. 2 used one month, perfect, $450; selling business. G. E. Hackett, 90 West St., New York.

For Sale—A No. 63 Fitchburg planer, good as new; can be had very reasonable. Apply, General Machine Co., Sunbury, Penn.

For Sale—Modern new steel brick lined shop and tools, four years in operation; new tools, electric crane, gas engine and motor drive; running day and night since January; owners will retain part interest and give management to right party; located in Central West. Box 760, AMERICAN MACHINIST.

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# Some Ancient Windmills on Cape Cod

## Immense Wooden Shafts and Wooden Gear Wheels Put Together with Pegs. Wonderfully Well Preserved Examples of Early Mechanical Skill

BY SNOWDEN B. REDFIELD

We are told by the weather man that the winds of the heavens are produced by the rushing in of cold air to fill up a space over some heated area of land whose atmosphere has been rarefied by expansion from this heat. This being the case, the windmill is a heat engine, operating through the medium of the expansion of air and it is strange that our mathematical friends have not seized upon this meaty subject to give us volumes of mathematics involving thermodynamics and British thermal units galore.

There is no desire to take the wind out of the sails of any mill by saying that the power obtained with a machine of ordinary size is very small indeed. Quite to the contrary, for the windmill is a very venerable invention; in fact, it may be that the first windmill was a contemporary of the first steam turbine, which we are told was invented by a Hero in the year B. C. two thousand and something. It is only lately, however, that the mathematician has gotten after the steam turbine and perhaps after all these years of neglect, a mathematician may one day get hold of the windmill, and if we do not know already, he may tell us why it works.

### The Breezy Cape

Cape Cod, as everyone knows, is a suburb of Massachusetts, just as Long Island is a suburb of New York City. New Yorkers go to Long Island as a playground. Bostonians and the people of Massachusetts go to Cape Cod for the same purpose. Some parts of Long Island are said to be quite thickly populated at the present day, but even the Bostonian will admit that Cape Cod is the "jumping-off" place, especially away out on the tip end where Provincetown, the first landing place of the Pilgrims from the "Mayflower," takes its grip upon the sand dunes to keep from being blown into Massachusetts bay. In fact, if there were any danger of the mathematician taking the wind out of the sails of the windmill as an efficient machine, there is certainly wind enough on Cape Cod to drive an unlimited number of mills. This is probably the reason why some of the first pieces of machinery built in America were some windmills erected on Cape Cod. These old machines were of the Dutch type and unlike the modern windmill, they were used for grinding corn. So well were they built by those early American "mechanical engineers" that a great many of them are today in almost perfect condition for operation, though most of them are over 150 years old.

FIG. 1. TWO WINDMILLS AT CATAUMET, MASS., OVER 160 YEARS OLD

As one takes a trip along the sandy stretches of Cape Cod one can see here and there the wide sweeping arms of these old mills, and whether or not the original builders realized it, they add a most picturesque feature to that country. As said, the mills are of the Dutch type; that is, the tower is a wooden building tapering up from the ground a distance of probably 40 feet, and either round or preferably octagonal in shape. The revolving portion, or what might be termed "the wheel," consisted of four long arms, on the outer ends of which, upon lattice framework, canvas sails were stretched. So long were the arms of some of these mills that measuring across the wheel from tip to tip the distance is probably 50 feet. Up in the peaked roof is the main shaft projecting out from a dormer window, and on most of them, as the arms swing around, their ends graze the earth with not more than 1 foot of clearance.

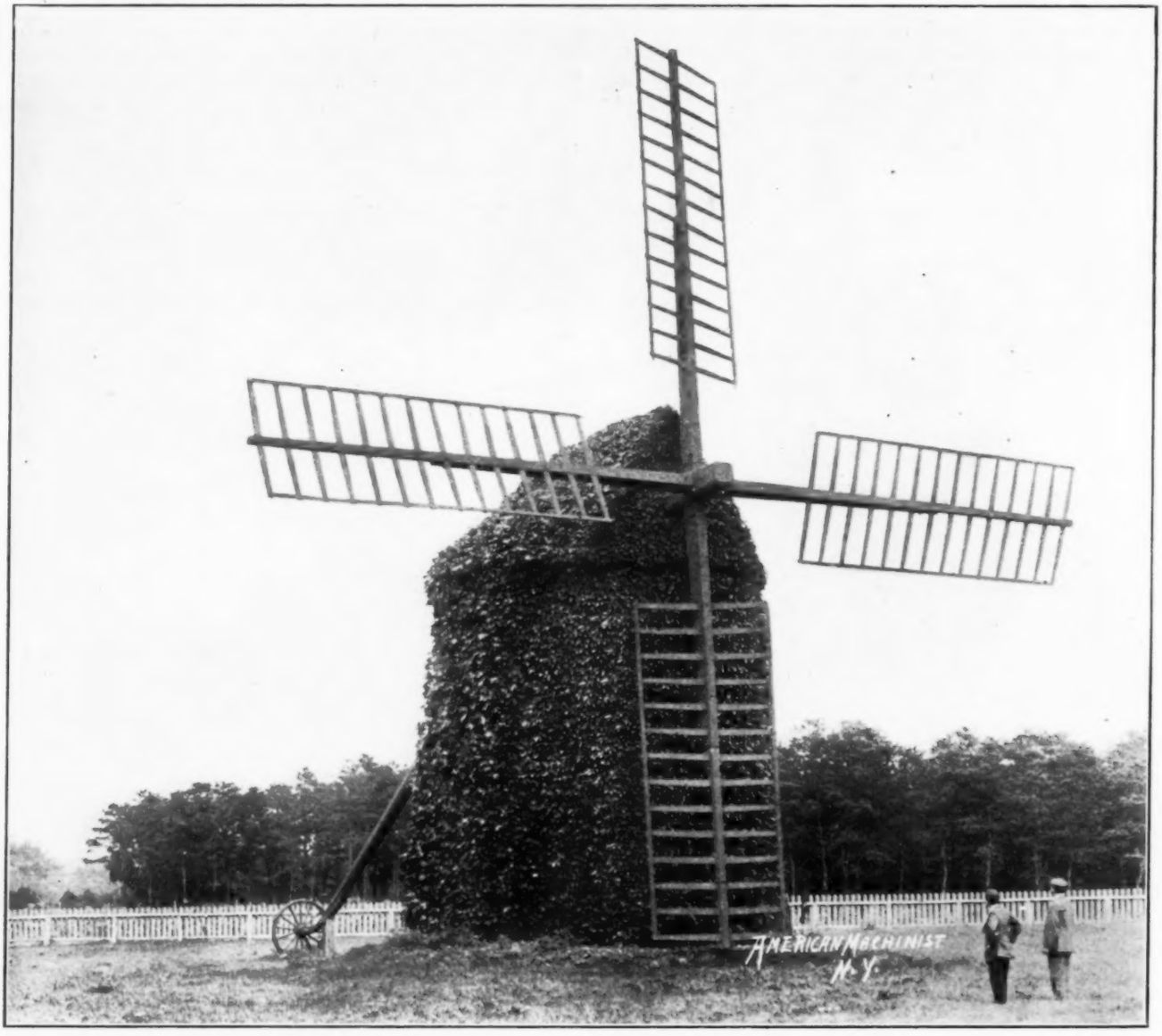


FIG. 2. ANCIENT WINDMILL AT WEST YARMOUTH, MASS. SAID TO BE THE OLDEST MILL ON CAPE COD, IN PERFECT OPERATING CONDITION TODAY

WOODEN PEGS AND HORSE-SHOE COTTERS

These mills are constructed almost entirely of tough, white oak, and this is probably the reason why they have lasted to the present day. There is hardly a nail in the whole structure of these mills, as the framework of the building, the cross-arms and the machinery are held together by oaken pins. There are a few iron bolts of old-style design, and some strap-iron yokes around various portions of the heavy beams, testifying to the skill of the village blacksmith. Some of these bolts are provided with screw threads and nuts, but in this iron work the cotter pin seems to have been a favorite style of construction. The bolt was forged with a rectangular hole through the end, and into this a piece of old broken horseshoe was usually thrust, forming a very satisfactory shape of pin to keep the parts drawn tightly together.

Each of these Cape Cod mills, even now, is provided with a pair of huge old-fashioned millstones, some of them nearly 6 feet in diameter and 14 inches thick. It is also claimed that some of these old stones were imported from Europe at great expense. In order to turn the mill wheel to face the wind they were not built as the modern type, with a guide vane to make it automatic in its facing, but the whole roof of the mill house was designed to turn around on a greased runway or circular track of oak. From the back of the roof portion, projecting from a second dormer window, a long heavy oak beam slanted downward toward the ground and there was strapped by iron yokes to another piece of oak which nature had caused to be gnarled in its development, this gnarling serving to give a piece of timber which is naturally bent and consequently of full strength. Upon the end of this was mounted a large wagon wheel to support the weight of the slanting beam. By

rolling this wagon wheel around the mill house the roof of the mill and the vanes of the driving wheel could be turned in any direction to face the wind, and it is probable that the correct position was assured by chaining the guiding arm to posts in the ground.

Although some of these venerable mills have probably not turned a useful wheel for 75 years, and although in some places the tall grass has grown up almost hiding it, it is not difficult in most cases to find the track of the guide-arm wheel in the shape of a circular mound probably 100 feet in diameter, completely circling the building and bearing testimony to the fact that in those days the winds were changeable even as they are today.

Most of these mills are now passing the days of their very old age as curiosities in their neighborhood. Many of them have been purchased by wealthy men and moved from their original locations to picturesque spots on their country estates. Most of them, as said, still have their machinery inside, although some have been somewhat rejuvenated and are used as parts of the summer homes. In these cases the architecture of the homes has been suited to that of the mills, and the picturesque effect of the old mill and the beautiful houses is often hightened by luxurious climbing vines.

Almost everyone must be impressed by these picturesque features, but to the engineer the old machinery and general construction of the mill is of far greater interest. In some of these structures the inhabitants are woodpeckers, darkness and spiders and some little climbing and groping is necessary to gain access to the working parts, but the mind combining a taste for both the ancient and the mechanical can have nothing but enthusiasm for these old pieces of machinery.

FIG. 5. PART OF WOODEN GEAR AND MAIN SHAFT IN EAST ORLEANS MILL. SHOWING WOODEN PEGS

### Machinery Made of Oak

Usually the main shaft of these machines is a piece of solid white oak about 24 inches in diameter, or square, as the case may be, and probably 20 feet long. They are magnificent pieces of solid wood and in these days would be exceedingly expensive. The cross arms were put right through the outer end of this shaft, one in front of the other at right angles, and the arms themselves are something like 10x12 inches, where they pass through the rectangular holes in the shaft, the shaft itself being reinforced by wrought-iron bands to take the strain. The splendid oak seems to have well stood the test of years as, even today, most of them are almost without a serious crack.

FIG. 3. EAST ORLEANS MILL MADE OF TIMBERS FROM AN OLD CHURCH OVER 100 YEARS AGO

FIG. 4. "MOTION PICTURE" OF WEST YARMOUTH MILL

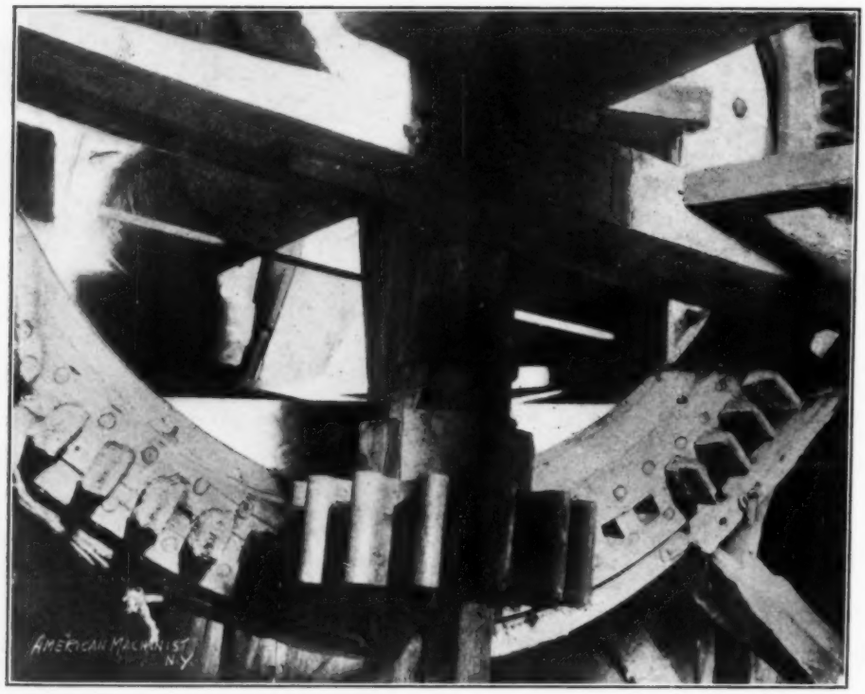


FIG. 6. WOODEN GEAR WHEEL AND CAST-IRON PINION. SHOWS BRAKE BAND, HORSESHOE COTTER PIN AND PROVISION FOR REMOVING VERTICAL SHAFT. EAST ORLEANS MILL

At the wheel end of the shaft a hollowed-out block of oak forms the main bearing and as wear was inevitable this pillow block was arranged for lifting by means of wedges underneath. On some of the mills a most peculiar style of bearing was used. On the main shaft, parallel to the axis just where it rests upon the pillow block, there are wrought-iron straps set in almost like gear teeth, around the complete circumference, although they are set flush with the oak of the shaft. These old pieces of strap iron are held in by iron spikes at each end and the object seems to have been to transfer the wear from the shaft to these pieces of strap iron, the block being renewed whenever that should become necessary. It would appear that these pieces of iron set at right angles to the motion of the turning would act almost like milling cutters and rapidly eat away the wooden pillow block beneath the shaft. It may be, however, that the pillow block was provided with strap-iron cradles upon which the irons in the shaft could bear, but this could not be determined without dismantling the machinery which was, of course, impossible.

Only a few of the mills appear to be equipped with this peculiar strap-iron bearing, the others relying upon the wood-to-wood construction; and one would be surprised to find that even now these old shafts and their long heavy cross arms can be revolved with but little effort. In fact, one mill said to be the oldest on the Cape will revolve of its own accord at the present day in a moderate wind, even without the canvas sails, as the pressure on the slanting wooden latticework upon which the sails were stretched is sufficient to turn the wheel.

### Grandfather of the Bevel Gear

Mounted upon the main shaft almost in the center of the tower is a heavy gear wheel made entirely of white oak. This wheel would have been a bevel gear if the constructors had known anything about bevels. As a matter of fact, it is hard to name the design, as the teeth are set in on the side face of the rim and are consequently radial although not conical. The rim is built up of oak sections, planed smooth, but only roughly hewn out. Layer after layer of these sections have been laid on to build up these wheels and four enormous wooden spokes, let into the 24-inch shaft and into the rim segments, transmit the power from the shaft to the rim. The whole wheel is held together by numberless oaken pegs instead of nails, and even in the oldest mill this wood is hard and almost flawless today. A few rough wrought-iron bolts serve to give additional strength.

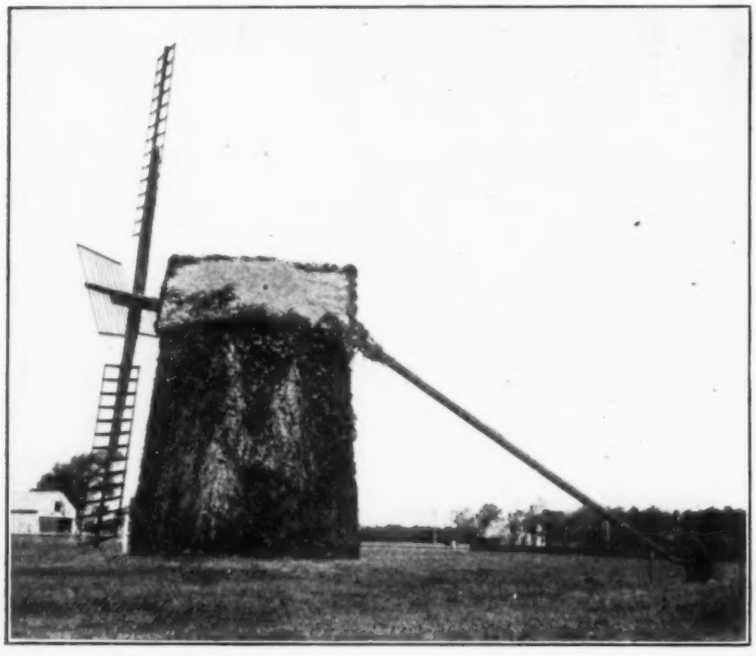

FIG. 7. WEST YARMOUTH MILL SHOWING TAIL ROD AND CART WHEEL

FIG. 8. OLD MILL NEAR HYANNISPORT, MASS.

White oak also forms the material of the gear teeth, which are wedge-shaped on the working end, with a square shank passing through the wheel rim parallel to the shaft; square holes to fit the tooth shank having been cut around the entire rim. On the back of the wheel the shanks of these teeth extend through in the shape of a round piece of oak about two inches in diameter and through these projecting sections wooden cotter pins were driven to hold the teeth in place.

As the rear end of the main shaft is not required to transmit the power of the mill, it is supported on a heavy oak timber merely by a round, wrought-iron pin about two inches in diameter driven into the center of the rear end of the shaft. This round pin revolved in a bearing made of a curved piece of wrought iron spiked down to the timber, which itself formed part of the roof bracing. A wrought-iron band encircles this end of the shaft to prevent any tendency of the shaft to split.

In one of these old mills the outer end of the shaft has been hollowed out in the center by a family of industrious woodpeckers, which have built their nest literally "in the heart of the oak." Fortunately this old mill is provided only with straight cross arms, as the latticework for the sails has many years ago rotted away. If it were not for this bare condition of the arms it might be that one day a strong wind would revolve the shaft and the woodpeckers would find their home turned upside down.

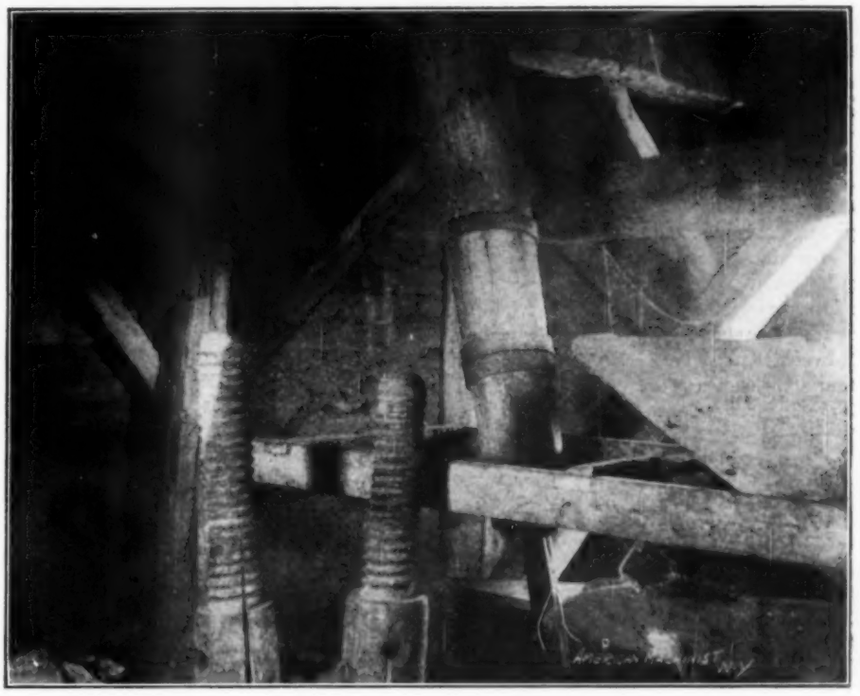

FIG. 10. GRINDING ROOM IN HYANNISPORT MILL. SHOWS VERTICAL SHAFT, CORN SPOUT AND CRANE SCREWS. ALL MADE OF WOOD

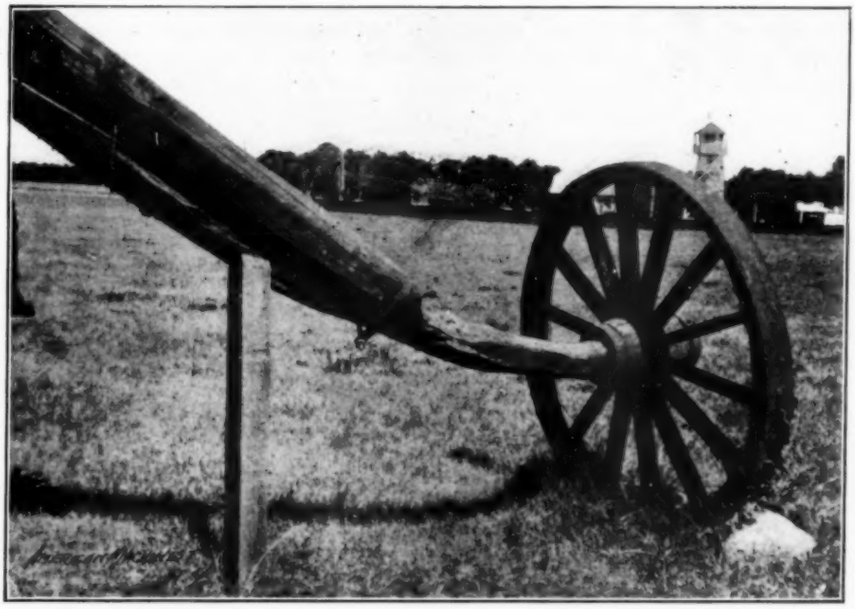

FIG. 9. TAIL ROD AND WHEEL. SHOWS CURVED OAK BEAM FOR AXLE. WEST YARMOUTH

### A Fluted Pinion

The wooden gear wheel on the main shaft is about 8 feet in diameter and this served to drive an ancient cast-iron pinion probably 18 inches in diameter which is mounted on a vertical wooden shaft. Here again is evidence that bevel gears were unknown in those bygone days, for the pinion is merely a spur gear and the irregular grinding of the oak teeth against the iron ones, due to their unscientific construction, has made sad inroads on the shape of the wooden ones. The great cross arms with their canvas sails must have been able to develop a fair amount of power, for it is thus seen that the heavy grinding stones were driven by the wooden gear wheel and iron pinion, at the ratio of about 8 to 1½, which is about 5½ to 1.

Though the pinions are made of cast iron it is evident that their makers knew nothing about spur teeth, to say nothing of levels, for the teeth are formed simply by a succession of tangent circular arcs. In other words, the teeth are round on the outer ends and also the clearance between them is round at the bottom. The teeth are thus heavily undercut, giving an appearance not unlike that of a deeply fluted building column and the radial wooden teeth of the main gear were obliged to transmit their power to this fluted spur gear. As the corners of the wooden teeth had the burden of the load to carry, it is not unlikely that some local mechanic was kept pretty busy at each of these mills hewing out new wooden teeth to take the place of those worn out in service.

The center of the iron pinion is cast with an octagonal hole about 1 foot across. This octagonal hole is tapered and after the wheel was slipped down over the end of the octagonal wooden vertical shaft wooden wedges were driven in between the pinion hub and the shaft, which seems to have been a very effective method of holding the pinion in place, for they are today as solid as they were when first installed. The wooden vertical shaft extended down through the mill and was something like 20 feet long, and as intimated about 12 inches across.

Near the bottom end of the vertical shaft was the upper millstone, which was made to revolve through the gearing by the action of the wind on the arms out-

side. In many of the mills the old grinding boxes with their funnel-shaped feeding troughs are still in existence and it is evident how the corn was put in through the hopper and dropped down through a hole in the center of the upper stone. The flow of the corn was controlled by a short wooden trough underneath the hopper which, by pulling a cord from below, could be slanted more or less down to regulate the flow of corn into the mill.

Support for the vertical shaft was furnished by a rough wrought-iron pivot about 3 feet long and not more than 1½ inches in diameter as an average. The pivot was supported at the bottom in a cast-iron cup resting on a heavy wooden cross-beam. When in operation the weight of the upper stone and the shaft would, of course, be taken by the corn being ground between the stones; consequently this bottom step bearing did not have to be very large in proportions. In fact the bottom bearing was only for the purpose of raising the upper stone a small amount, as the cross-beam at the bottom, by means of iron hooks and knife edges was arranged through a system of heavy wooden levers to be raised up and down to a slight degree.

### The Original Traveling Crane

One feature most interesting to the combined engineer and antiquarian is the method used for taking out the worn millstones for re-dressing. In an old mill at East Orleans this takes the form of a crude traveling crane. Across a gap between the timbers in the upper chamber there stretches an oak beam probably 10x10. The ends of this beam are rounded off so as to form bearings about 5 inches in diameter and 16 inches long. On these bearings are mounted cylindrical sections of the trunk of an oak tree. These cylindrical pieces act as rollers for the traveling crane and for some reason the bearings of these rollers have been reinforced by the insertion of cylindrical sleeves of wrought iron which loosely slip over the wooden shaft of the cross-beam. Large wooden cotter pins hold the cylindrical rollers in place on the shaft and around the circumference of the rollers

FIG. 11. VERY OLD MILL AT CATAUMET WITH DOME ROOF AND TURNING WHEEL

deep square holes were cut for the insertion of turning bars.

Suspended from the cross-beam are two wooden tension members which hang down to a level with the upper millstone. The millstones themselves were provided with holes drilled into their rims spaced diametrically opposite and when one of the suspending arms of the traveling crane was brought opposite each side of the stone a wooden pin was driven through holes in the bottom end of the suspending arms right into the holes in the rim of the millstone. This, of course, was done after the upper stone was lifted by means of the system of beam levers below, already described. After this it is probable that the vertical mill shaft was lifted up and removed and then by the insertion of the turning bars into the square holes in the rims of the cylindrical rollers of the traveling crane, the crane with its millstone hanging below, was rolled across the timbers to one side. Here, the stone could be revolved upon its suspending pins to turn bottom up so as to make it easy for the stone cutter to re-dress the surface. This is the only one of these traveling cranes which the writer found upon the Cape.

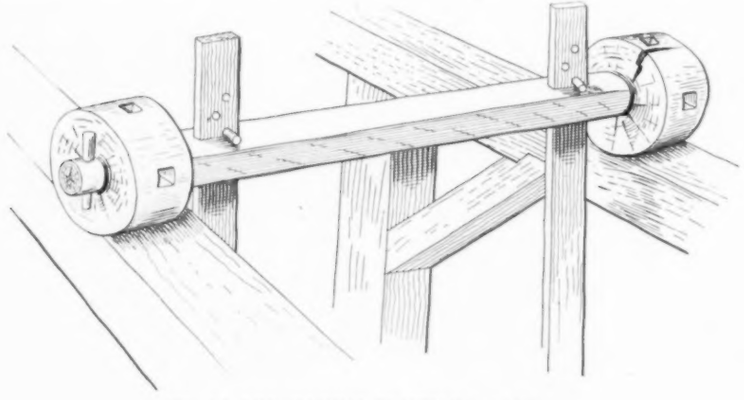

FIG. 12. THE ORIGINAL TRAVELING CRANE

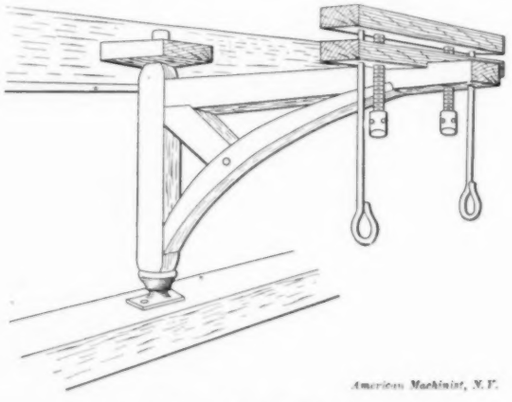

FIG. 13. THE BEGINNING OF THE JIB CRANE

### Ancient Jib Cranes

In most of the mills there was a very interesting form of jib crane which was of handier form as better means were given for raising the stone from its seat. The jib crane proper is of usual form as seen in foundries of the old type, being made of heavy timbers, and in some cases the diagonal supporting strut is made of a piece of naturally curved oak rather than a straight piece, giving more clearance between the supporting strut and the machinery.

On the outer end of the upper horizontal beam of the jib crane and at right angles to it there was set a cross-beam about 10 feet long, projecting equally on each side of the main crane beam. At the outer ends of the cross-beam, holes were bored and screw threads cut in the wood. Into these threaded holes heavy oak screws about 4 inches in diameter by 2 feet long were set from the bottom, the screw heads being enlarged and provided with holes for the insertion of turning bars. Upon the upper ends of these screws rested another cross-beam, the same thickness and length as the cross-beam carrying the screws. Further out on the upper cross-beam were suspended at each end wrought-iron rods about 6 feet long, these rods projecting through holes in the lower cross-beam so as to act as a guide. At the bottom of these suspending rods there were other holes for the insertion of pins to project into the millstone just as in the case of the crude traveling crane.

Now the operation was to swing the jib crane around so that its cross-beam projected across the diameter of the millstone and the two suspending rods hung down on each side; then the wooden pins were inserted through the suspending rods and into the diametrically opposite holes in the rim of the millstone. The wooden screws on the outer end of the lower

cross-beam would then be given a half dozen turns, thus lifting up the upper cross-arm and lifting with it the upper millstone. Next the whole crane was swung around to one side and the stone turned over on its wooden pins so as to be bottom up, for redressing as before.

### How Old and Where They Are

As to location and a very little bit of the history of these old mills. They are dotted all over the Cape, and the history of many of them is lacking. At East Orleans is an old mill now preserved as a relic and having its machinery practically complete, although the latticework for the ends of the wheel arms lies rotting in a nearby field. This is the mill which is provided with the curious rolling traveling crane already described. There is an old lady in this neighborhood who is now 95 years old and who remembers the time in 1819, just 90 years ago, when this old mill was moved to its present location.

Tradition says that the timbers of this mill originally came from an ancient church, in some other neighborhood. Nobody knows just how long ago this church was transformed into a mill, but it is fairly certain that even before 1819 this mill was doing service in a place called Snow's Hill. There is every evidence in the interior that the old beams were not originally cut to make the mill, for there are many notched-in portions showing where other timbers of the church building once rested, these timbers not being necessary in the mill construction. Furthermore, there are many old empty dowel holes whose oaken pins were probably lost over 100 years ago when the church was torn down.

Tradition further says that in the old days of corn grinding in this mill the farmer bringing in corn was obliged to pay the mill owner two quarts of meal per bushel ground. Later on, just as in these days, the price of living seems to have been going up, for it is related that the toll was raised to three quarts per bushel. It is also said that it took 20 minutes to grind a bushel of corn. The old diagonal guide arm which used to belong to this mill in its useful days is now missing, but the circular mound upon which traveled the wheel on the end of the beam is still plainly visible in the tall grass.

FIG. 15. DETAILS OF WEST FALMOUTH MILL.

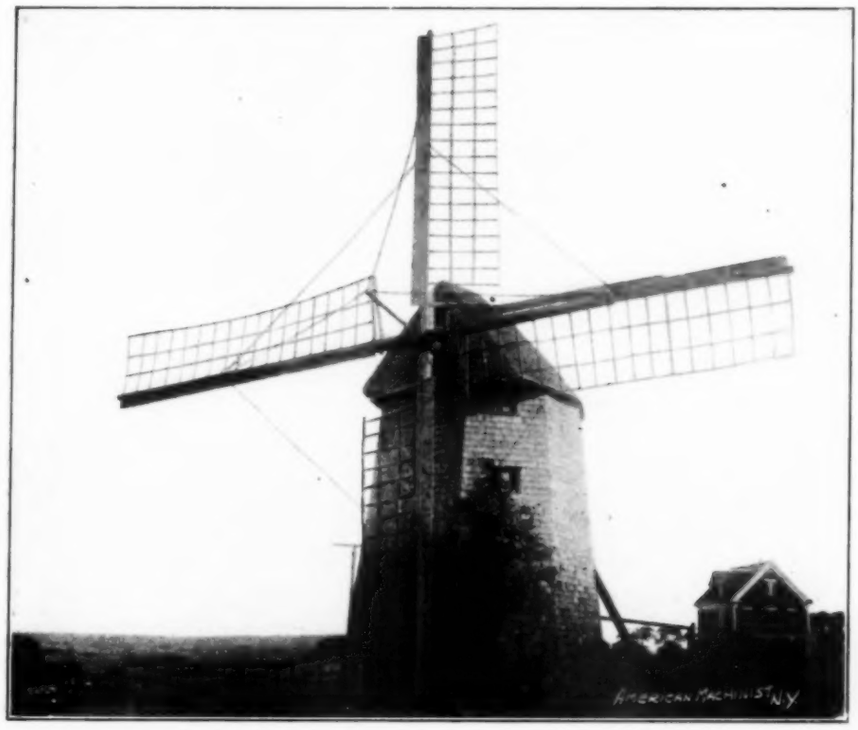


FIG. 14. MILL AT WEST FALMOUTH, MASS., 122 YEARS OLD. SHOWS BRACING RODS

### A Wooden Band Brake

In this mill also the machinery is so well preserved that the ancient wooden brake which was applied to the rims of the main wooden gears of all these mills for stopping purposes, is still perfectly preserved. This wooden brake is in the shape of a band circling completely around the rim of the main wooden gear, and is made up of sections of curved oak, the sections being hinged together by crude wrought-iron links. The stationary end of the brake band was held by a yoke consisting of two wooden links fastened to a cross-beam of the roof structure, the necessary swinging joints being provided by rough wrought-iron bolts and horseshoe cotter pins. The free end of the brake band was extended into another section of curved oak, passing down between the yoke pieces and into a wooden lever about 10 feet long and 6 inches square. The fulcrum end of this lever was supported in a wooden bracket suspended from a roof beam and the link leading to the brake band passed into a rectangular hole cut through the lever and pivoted by another wrought-iron bolt and horseshoe cotter.

Ropes led from the end of the brake beam down through the floor to the grinding room below, and when it was desired to stop the mill the brake lever was pulled downward, applying friction to the rim of the main wooden gear, gradually bringing

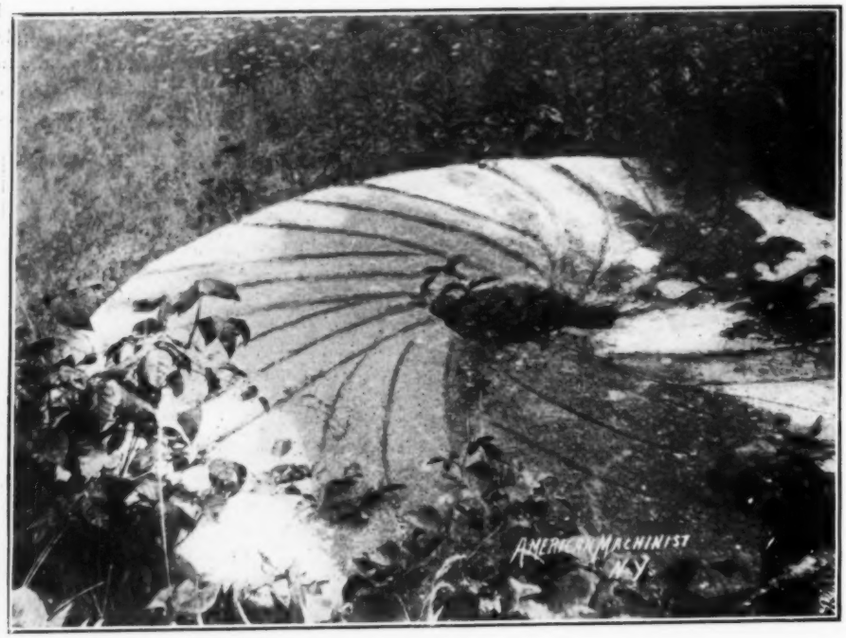


FIG. 16. IMMENSE MILLSTONE AT WEST FALMOUTH, MASS., SHOWING CURVED GROOVE DRESSING

the mill to a stop. To remove the strain from this mechanism when the mill was not in use, large iron staples were driven into the corner beams all around the outside of the octagonal structure of the building and into these staples rough wrought-iron chains were hooked, which stretched to the cross-arms of the windmill, thus holding it rigidly even in the strongest gale.

### The Oldest One

At West Yarmouth on the southern shore of Cape Cod about half way out to what might be termed the "elbow," where the Cape turns sharply north, is a mill which is supposed to be the oldest one on the Cape. It used to be thought that this one was about 175 years old, but antiquarians of late, looking into its history, now claim that it was built many years before that; some asserting even that it is as much as 300 years old. This, however, is a matter for the antiquarian to decide, but it must be said that this mill, which is now carefully guarded by Ferdinand A. Abell, whose handsome residence is directly opposite the mill, is in the most perfect state of preservation. All the parts are complete in every particular, including the guide arm at the back with its large cart wheel and all the gears and levers in the interior. It was brought to its present location, for preservation about 15 years ago, and since that time the mill has actually been used for grinding corn simply to show that its condition is still perfect. In the moving of this mill the pieces were not taken apart, and consequently now stand just as it was put together by the skilful hands now long since gone. The only new portions of this structure are the lattices on the ends of the arms for supporting the canvas sails; the arms themselves are parts of the original structure.

At Hyannisport is the old Namsitkit mill. There seems to be some discrepancy in the spelling of this name, for it is sometimes given as "Namskatsit." The construction of this mill is about the same as that of the others, but two of the cross-arms are missing. The old tail rod and the cart wheel are still in existence, and in this case the tail rod was braced to the revolving-roof structure by links of wrought iron.

West Falmouth, not far from Woods Hole, boasts another ancient mill, which from its exterior, is practically complete. Upon the door there is a sign which states that it was erected in 1787, which is 122 years ago, so that this one is of more modern construction than some of the others. This is further shown in the mill itself,

FIG. 17. MILL AT CATAUMET, MASS., 164 YEARS OLD

as the cross-arms are quite extensively braced by wrought-iron rods. These rods reach from one arm to the other and also forward from each arm to a wooden strut, which extends out from the end of the shaft at its axis. These braces are called for by the fact that the arms are of unusual length. The peculiar strap construction was used also for the bearing of the main shaft which carries the revolving arms.

Near Cataumet are three old mills. Two of these are on the property of J. J. E. Rothery, of Boston. Both of these are used for living purposes, as the machinery has long since been removed. The exteriors, however, are in perfect condition as far as the buildings are concerned, although two whole arms and part of another arm of one of the mills are missing. One of these mills is known to be 164 years old, having been transported from New Bedford, its original location.

Another style of construction is seen in the third of the Cataumet mills. In this case the roof, instead of being either conical or peaked, is dome-shaped, and the turning of the wheel head was accomplished by a pinion in the eaves and a wheel on the outside, turned probably by an endless chain. Unfortunately most of the details of this old structure have long since passed into decay, and this fact, together with its different construction, may indicate that it is of even greater age than its neighbors.

## A Large Automatic Brick Press

By Harry F. Atkins

Some years ago I designed a machine for pressing bricks for a private engineering works in connection with a large brick-manufacturing concern. It was for their own use, and only one has ever been made; but it not only pressed bricks with great speed and efficiency, but is also a very interesting piece of mechanism to those not connected with brick making, who have the engineering turn of mind.

As will be seen from the photographs, it is a huge machine standing firmly on four legs. Its body revolves continuously and slowly, while two arms travel with it, dipping their plungers into the pockets of the cylindrical body like great insects after the honey in a flower, when suddenly one arm lets go and swings rapidly back to its starting point and begins again on the next pocket.

The arm motions are extraordinary, and the first impression is one of surprise followed by riveted attention. However, one soon becomes reassured and can even, after a time, take his eyes off these erratic and almost intelligent motions and watch the bricks pouring out of the monster to be carried off by a traveling belt for burning in the kilns. It has been nicknamed "The Octopus," a name not unsuited to the impression of its appearance upon the mind. It really requires the help of a cinematograph to illustrate the machine at all adequately. In fact, it would seem that this would be an ideal method for giving an attractive idea of anything in the shape of automatic machinery, and could be done in a simple manner at no very great expense.

reference to letters.

In the description of the mechanism of this machine I will try to avoid tedious

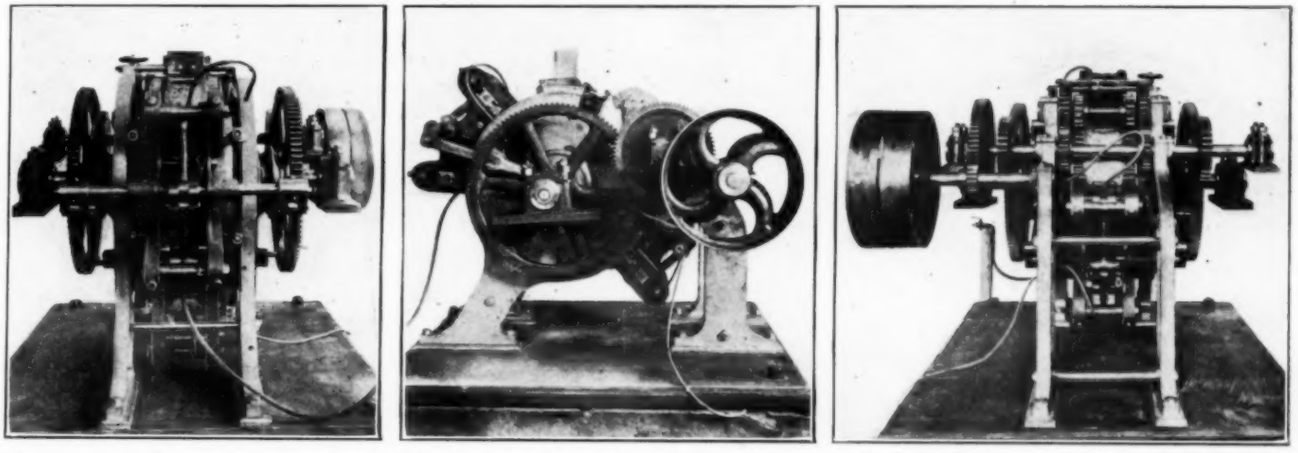

FIG. 1. FRONT, SIDE AND REAR VIEWS OF BRICKMAKING MACHINE

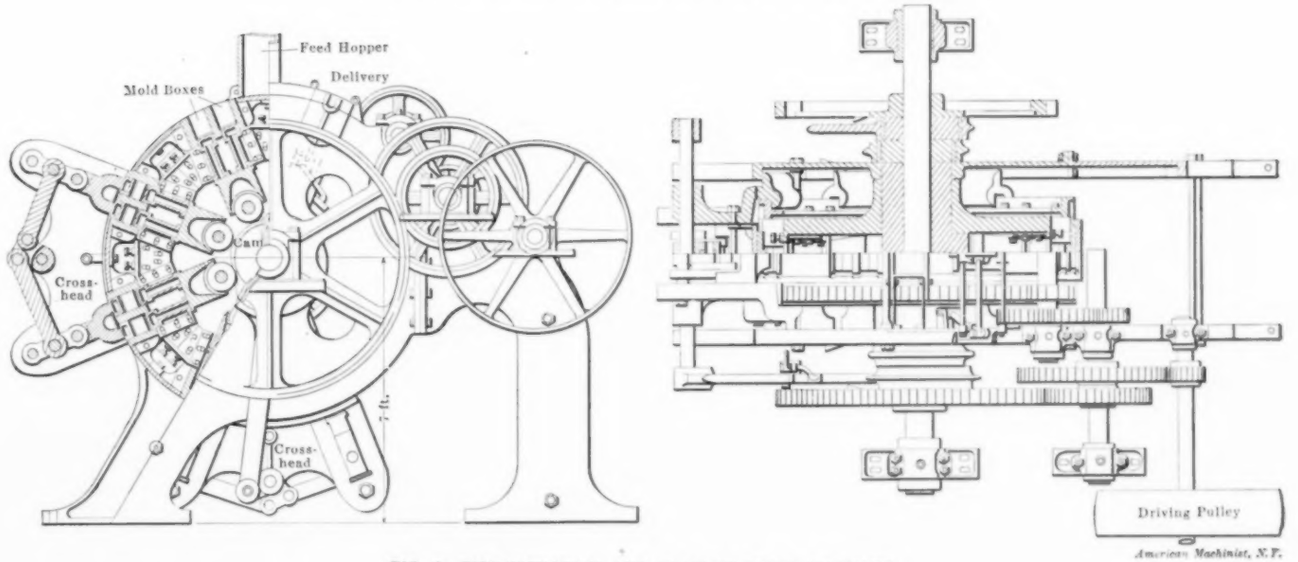


FIG. 2. SIDE ELEVATION AND PLAN OF BRICK MACHINE

The initial aim was to build a machine that would turn out a large number of bricks while occupying a small floor space and using as little power as possible to drive. In the main its parts are few and simple. Fig. 1 will give an idea of its general appearance. Fig. 2 shows elevation and plan, both in part section. The main body is a cylinder carrying eight pairs of mold boxes. In these mold boxes is a set of plungers worked by a stationary cam in the center, and into these mold boxes the two large traveling crossheads, by means of toggle levers, thrust plungers from the outside. Each crosshead thrusts its set of four plungers into all the mold boxes, so that each brick gets two distinct pressures, one from each crosshead. This is necessary from the nature of the clay. The cylinder is driven continuously in one direction, and carries the two crossheads with it while they are doing their work.

On the outside of the frame of the machine, one on each side, are two large wheels revolving in the opposite direction to the cylinder and at a much greater speed. These wheels serve two purposes. When the crossheads have done their work they are picked up by these wheels and taken back to their starting point, to be once more coupled to the cylinder over the next two pairs of boxes. They also drive a pair of eccentrics, the straps of which are connected to the toggle motion of the machine, which gives the motion to the plungers in the crosshead for the "top" pressure. These eccentrics actuate the toggle motions while the crossheads travel with the cylinder, but as soon as the large wheels take up the crossheads to return them to their starting points, the action of the eccentrics is destroyed owing to the fact that both eccentrics and straps are moving at the same circular speed.

Semi-dry clay, finely ground, is fed through a chute at the top of the machine, and the finished bricks are delivered by the arrangement shown immediately to the right of the chute. All the plungers are steam heated to prevent the clay from sticking to the die plates and mold boxes.

I have prepared a set of four diagrammatical drawings, Figs. 3, 4, 5 and 6, showing the positions of plungers, etc., at the critical points in the cycle of operation, which will show the action.

Fig. 3. Molds 1 and 2 have been charged as they passed under feed hopper, and top plungers are just ready to enter to give the first pressure. Molds 5 and 6 are receiving their final pressure, while bricks from molds 8 are being delivered.

Fig. 4. Plungers are just entering molds 1 and 2. Plungers have left molds 5 and 6 and are ready for return stroke.

Fig. 5. Molds 1 and 2 are receiving the full first pressure. The plungers from molds 5 and 6 are now ready to enter molds 3 and 4, while bricks from molds 7 are being delivered.

Fig. 6. Plungers from molds 1 and 2 are now ready to return to position in Fig. 1 to take up molds 7 and 8 which have been filled. Molds 3 and 4 are receiving their full final pressure.

The output of this machine is about one brick per second, or 160,000 per week. The cylinder is 8 feet in diameter, and each brick is subjected to a pressure of 40 tons, while the stress for one pair of bricks only comes at one time.

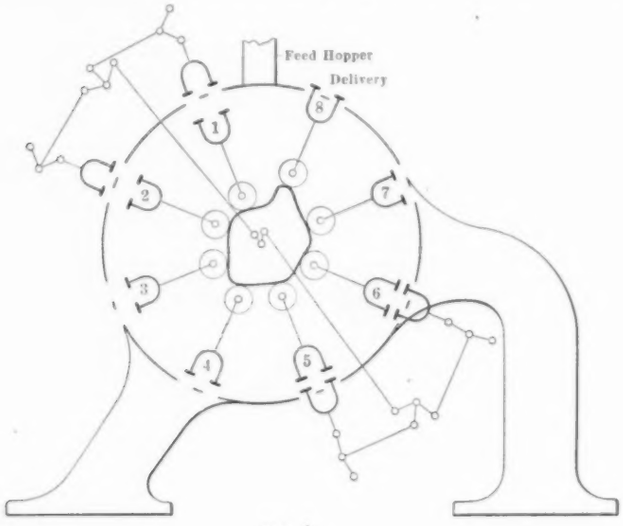


FIG. 3

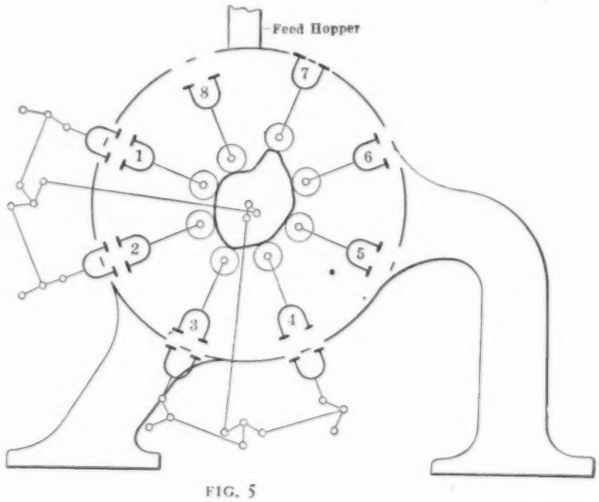


FIG. 5

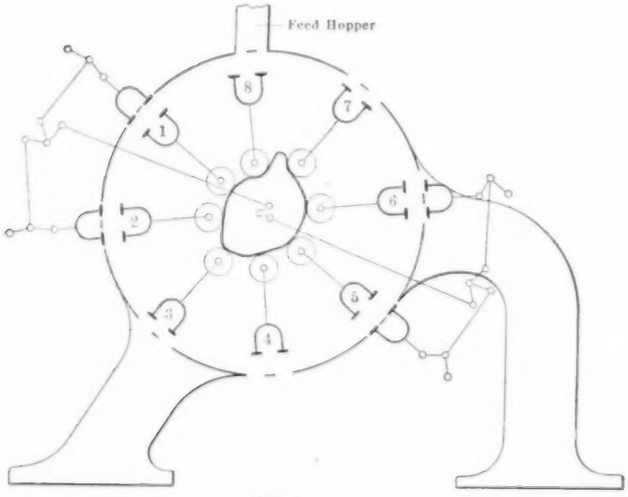


FIG. 4

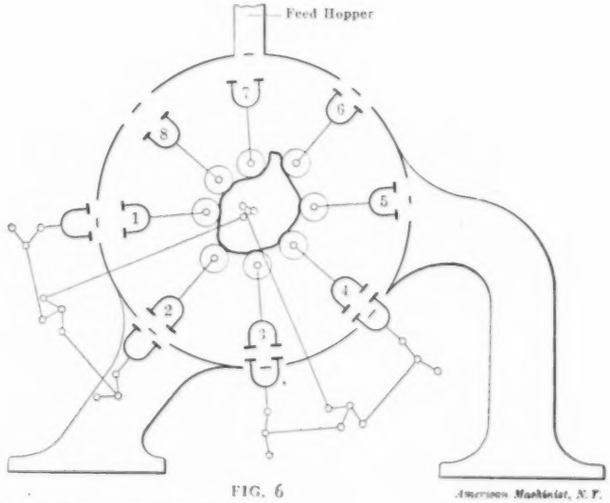


FIG. 6

American Machinist, N.Y.

"MOTION PICTURES" SHOWING OPERATION OF BRICK PRESS

# Principle of Planimeter Operation

## Showing That the Planimeter Is a Device of Simple Construction and Its Principle of Operation Is Not at All Difficult to Understand

BY M. R. WELLS

The writer well remembers with what awe he listened to his big sister some years ago when she made her first visit home from college and had some wonderful things to tell her little brother. I was then just at the point in school where I had learned to find the area of a rectangle or square (which I thought required great skill), and consequently when she told me that there was an instrument which would read off directly the area of any figure regardless of whether it were round, square or any other shape, I nearly dropped off my chair. I imagined that it must be a machine full of all kinds of wheels and intricate mechanism and never did get over this idea until several years later when I saw the actual planimeter. I was certainly struck with its simplicity as regards looks, but in spite of that, its principle was still a mystery to me. Even when at college later on and able to give the calculus proof for the planimeter, the matter was not clear to me until one night, while lying awake, I studied the whole thing out in the dark. My course of reasoning seemed to make the matter clearer

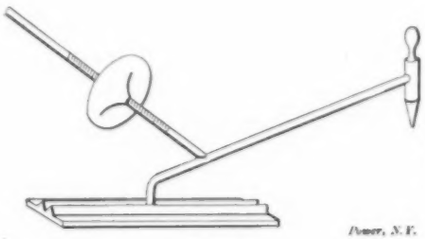

FIG. 1

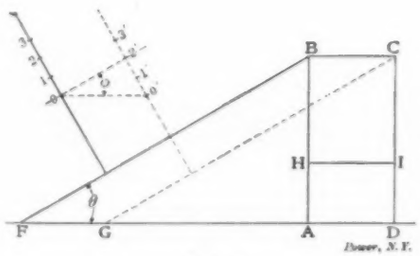


FIG. 2

to several of the boys at college and may be of interest to some others who have perhaps used the planimeter for years and who yet would be unable to make one or tell just what was wrong with it in case it failed to give correct readings.

In starting, let us consider a planimeter similar to the one shown in Fig. 1. It will be seen that this consists of a rod or wire having a tracing point at one end while the other end is bent down and slides back and forth in a straight groove. At right angles with the first rod is a second rod upon which is a knife-edged roller which is free to roll and also slide along the rod. Along this rod are graduations which indicate any movement of the roller along the rod and not that due to revolving. With this type of planimeter it will be seen that the diameter of the roller has nothing to do with the accuracy of the instrument.

### Area of Rectangles

Referring to Fig. 2, let line $F B$ represent the tracing arm, $F G A D$ the groove

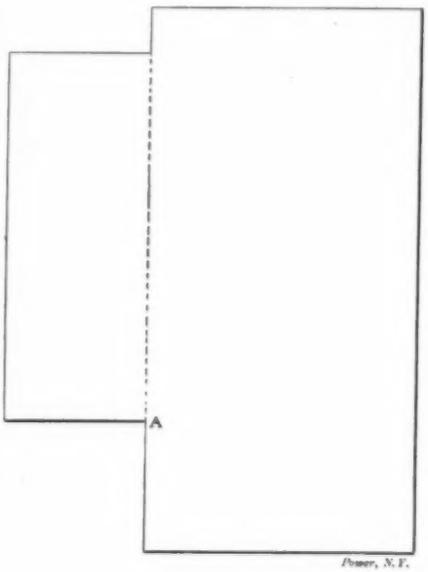


FIG. 3

in which one end of the tracing arm slides, and $A B C D$ the rectangle whose area is to be found. The lower side of the rectangle has been taken as lying on the groove for the present in order to make the case more simple. It might be well, for the sake of any who may not have used a planimeter, to state briefly the method of using most of them. The tracing point is placed at any convenient point on the edge of the figure whose area is desired. It is quite customary to press the point hard enough into the paper to make an impression which will indicate when the entire outline has been traced. The recording disk or roller is then usually set at zero and the outline of the figure traced in a clockwise direction. When completely around, as indicated by the dropping of the tracing point into the indentation made at starting, the disk will have moved a certain distance along the rod and the graduations will show the area which this movement corresponds to. Let us follow this procedure with the rectangle, starting at a point $B$ and stopping at $C$. It will be evident that the roller will have traveled along the line $o\,2'$, while

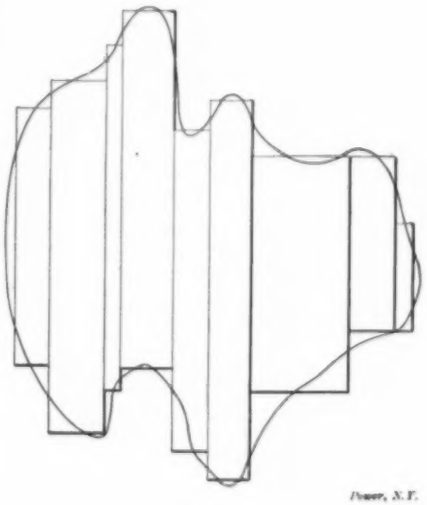

FIG. 4

the mark o on the graduated scale (where the roller was started) will have traveled along the line $o\,o'$, which is parallel to the line $B C$. It is thus clear that the roller will have moved two graduations along the rod in tracing from $B$ to $C$.

In going from $C$ to $D$ the roller will move a certain distance, which does not count since there will be an equal and opposite movement in going back from $A$ to $B$. In going from $D$ to $A$ it will be seen that the roller will simply revolve on the rod and will not move along it, since the path of the roller is parallel to the line which is being traced. In going from $A$ back to $B$ the movement of the roller will be equal and in the opposite direction to what it was when going from $C$ to $D$. To sum up, let us see what the final position of the roller is upon the rod. Going down one of the sides was just counteracted by going up the other. Across the bottom caused no movement of the roller, hence the only permanent or final movement along the rod was caused while going across the top, and is equal to $o'\,2'$. Now the following points may be noted:

Angle $\Theta$ always equals angle $\phi$, therefore,

$$sin.\ \Theta = sin.\ \phi = \frac{o'\,2'}{oo'}.$$

Movement of roller along rod (reading) equals

$$oo' \times sin.\ \phi = oo' \times sin.\ \theta.$$

Since $F B$, the planimeter arm, is of a constant length, C, the hight of the rectangle, equals

$$C \times sin.\ \theta,$$

and the width of rectangle $B C$ equals $oo'$.

The area of the rectangle is equal to the hight times the width, or, from the above,

$$Area = C \times sin.\ \theta \times oo'.$$

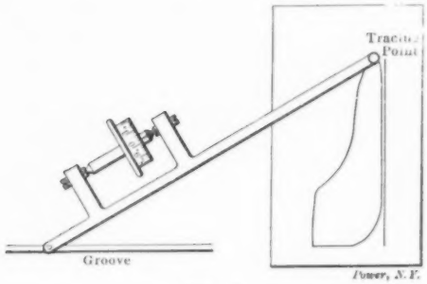


FIG. 5

This is the same as the movement of the roller multiplied by a constant $C$, hence to find the area of any rectangle having one side along the groove, it is only necessary to multiply the movement of the roller (in other words, the reading) by a constant $C$. The method of determining the value of $C$ will be given later.

For the second case, where the figure does not rest upon the groove, take the rectangle $B C I H$. In tracing from $B$ to $C$, as was found before, the movement of the roller will indicate the area of the large rectangle $B C D A$; the movement in going from $C$ to $I$ will be just counteracted in going from $H$ to $B$, and hence need not be considered; in going from $I$ to $H$ the movement will correspond to the area of $H I D A$, but since tracing in the opposite direction from that while recording the area of the large rectangle, the area below the line $I H$ will be subtracted, and hence the final or resultant reading will be the difference, or the area of $B C I H$, the figure traced.

### A Combination of Rectangles and Irregular Figures

By similar procedure, it may be shown that the instrument is all right for a combination of rectangles having different dimensions, as in Fig. 3. If not perfectly clear to the reader, it may be well to trace the first rectangle, starting from $A$, and then, without lifting the tracing point, go over the second, noting that the line shown dotted will be retraced and since in the opposite direction the second time might just as well not have been considered. By adding one rectangle at a time it will be clear that the instrument will properly indicate the area regardless of the number or size of the rectangles.

In Fig. 4 the area of the rectangles shown is the same as that of the irregular figure. By making the rectangles narrower and narrower, it will be seen that their combined outline can be made as close as desired to the outline of the irregular figure, hence the planimeter works equally as well on any irregular figure as on rectangles.

### How Scale is Indicated

To determine the constant $C$, previously referred to, simply assume a rectangle whose hight is equal to the length of the tracing arm and whose base rests upon the groove. In tracing across the top (and thus indicating the entire area), it is evident that the tracing arm must stand at right angles to the groove, and hence the rod upon which the roller moves will be parallel with the groove. For this reason the roller will stand still and the rod simply slide in it, or, in other words, the movement of the roller with respect to the rod will equal the width of the rectangle. Now the area of the rectangle is equal to the hight times the width, or, from above, the length of the tracing arm times the movement of the roller. Hence it is evident that the graduations upon

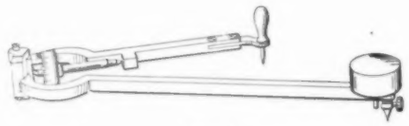

FIG. 6

the roller rod should be such that the distance between any two fixed points or marks should equal whatever that distance represents divided by the length of the tracing arm. For instance, if the arm is 6 inches long, the distance on the scale which represents 3 square inches must be ½ inch.

### Variations in Design

The operation of this simple type of planimeter has probably been made clear to the reader, but since it is seldom used in this form, let us consider the form shown in Fig. 5. Here it may be seen that the only radical difference is in the roller position, the axis being parallel with the center line of the tracing arm instead of at right angles. Neither does it slide along the rod but rolls, the reading being shown on a scale which revolves with the roller. The edge of the roller is not sharp, as was true in the first case, and hence slips over the paper when the movement is parallel with its shaft, but rolls when the movement is at right angles. A little thought will show that a point upon the circumference of the roller will move a distance corresponding to the sliding motion of the roller in the first case.

By the same procedure as in finding the first constant, it will be evident that the circumference of the roller multiplied by the length of the tracing arm, must equal the area indicated by one complete revolution of the roller.

As the next step, consider the form shown in Fig. 6. The only material difference between this and the style shown in Fig. 5, is that the one end of the tracing arm follows an arc of a circle instead of the groove or straight line. Going back to the Fig. 5 type, consider the groove as being divided into several short, straight sections, as shown in Fig. 7. Dotted lines separate the irregular figure into portions, each of which can be traced while only one corresponding straight groove is being used. Tracing the figure portion by portion and remembering that the dotted lines can be neglected on account of being retraced, will show that the planimeter is correct regardless of the shape of the groove, the only essential being that the end of the tracing arm shall return over the same course it followed in going out. Thus it is plain that an arc can be used, and in many cases is more convenient than a groove.

For use in determining the average hight of an indicator diagram, the groove type has this advantage. By placing the card with one end resting upon the line of the groove and with the atmospheric line at right angles to it, tracing can be started from a point at the farthest end from the groove. Set the scale at zero and, instead of reading the scale after having traced the diagram, simply move the tracing point along a line parallel with the groove until the scale again reads zero. The distance necessary to bring the scale back to zero then indicates the

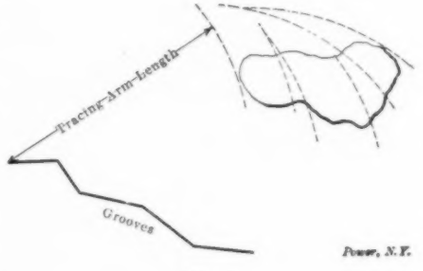


FIG. 7

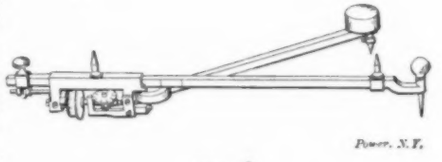


FIG. 8

average hight of the diagram and does away with the necessity of dividing the area of the diagram by the length, as must be done when using the instrument shown in Fig. 6.

Fig. 8 illustrates a planimeter, the length of whose tracing arm can be varied so that the instrument may be made to read directly in square centimeters, inches or feet. If, by means of the points shown, the length of the tracing arm is set equal

to the length of an indicator card, the average pressure can be read directly when certain indicator springs are used. For instance, if the circumference of the roller is 2½ inches and one complete revolution indicates 100, the reading would be correct for a 40-pound spring (100 ÷ 2½ = 40). If an 80-pound or 160-pound spring has been used, it is easy to multiply the reading found by 2 or 4, as the case may be.

## A Variety of Planer Ways

By C. A. Heald

The designing of ways for lathes and planers has furnished opportunity for a wide difference of opinion among designers and the description of the planer V's recently brought out by a firm in France coming at the present time brings this difference forcibly to mind, owing to the fact that, at the beginning of the financial depression, our shop had drawings and patterns ready for a 24-inch planer and having V's of similar shape, with the difference that the steep sides were on the inside of the bed, while those of the Lamont & Hurtu planer are on the outside. Our V was 25 and 65 degrees angle where theirs is 30 and 60 degrees.

### New Form of V versus Modified Regular Form

During the dull times the new V's on the pattern were the subject of much discussion by the members of the firm, selling-house agents and prospective customers. It was finally decided that the advantage of the new V was largely speculative and that the same results would be better obtained by using the regular V in combination with the lip shown in the sketch added to the table to do what the steep side of the V was supposed to do.

A companion of the various styles of planer ways may be of interest and the following sketches illustrate the different styles put out by one firm within the last eight or ten years.

Fig. 1 shows the proposed pattern which was discarded for Fig. 2, with the web extending down on the inside of the bed and made a running fit, to take up all tendency to crowd over under side thrust. At Fig. 3 is shown a V of 80 degrees included angle and having the side of the table extended down to fit over the sides of the bed. This style of V was made to a customer's order and on a later order they had binders added as shown at the left side of the table.

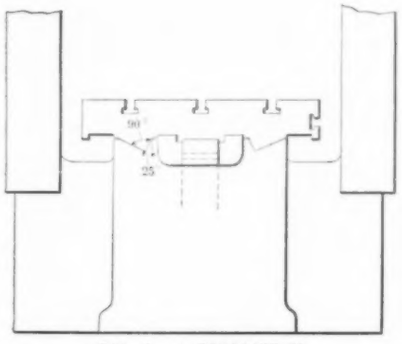


FIG. 1. A PROPOSED V

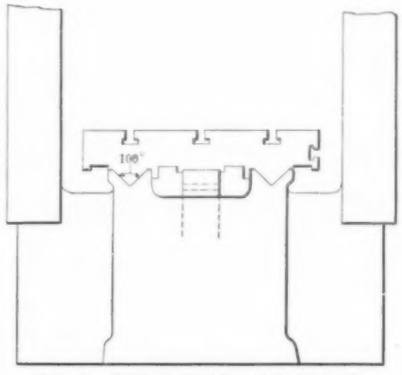


FIG. 2. THE V THAT WAS ADOPTED

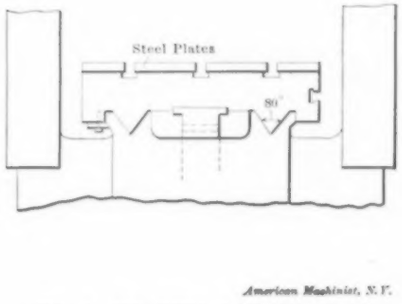


FIG. 3. BED WITH EXTENDED SIDES

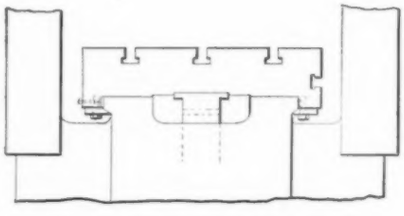

FIG. 4. THE WAYS AND BINDERS

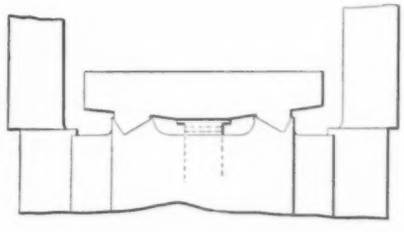

FIG. 5. LAMOND & HURTU PLANER V

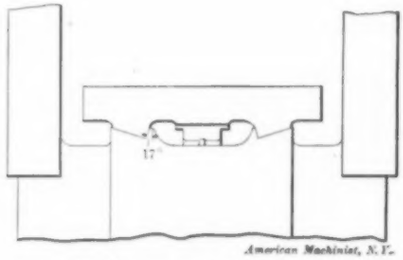


FIG. 6. AN OLD PLANER BED

These planers were for frog and switch work, and had a steel covering fastened on the top of the table, as shown in the sketch.

Fig. 4 has flat ways and has the table extended down on the outside of the bed and a gib on the back side to be adjusted by screws, as well as binders to prevent lifting under a heavy cut. This machine was also for switch and crossing work.

Fig. 5 is a sketch of the new Lamont & Hurtu planer V. I do not know if this firm considers this something new, but after some searching I was able to dig out a drawing of a machine which a firm in this vicinity was called on to repair some years ago, and which drawing shows the same style of V with the steep side inside, but the angle of the steep side was about 17 degrees with the vertical as near as I could make out from the drawing, which was to a small scale. This was an 84-inch planer made by a Scotch firm and antedates our new models by some years. The table of this planer was driven by a double-helical gear which would seem to account in part, perhaps, for the steep side of the V, as a crowding over the table under side thrust would have obvious disadvantages with the double-helical rack and gear, which would not obtain with spur gearing. The lubricating of the steep side of the V might cause some trouble, it being so nearly vertical, owing to the tendency of the oil to run to the bottom of the V, leaving the top part nearly dry unless carefully looked after.

### Medium Steep V Recommended

While recognizing the fact that some classes of work require means of preventing lifting and wide movement of the table, and that each style of ways shown has its merits, it is the opinion of the writer that as between the 80-degree V, with its wedging friction when under pressure and the flat ways with its gib adjusted by screws and liability to misadjustment, that a medium steep V, say, 100 degrees, and a binder so fitted as not to add to the friction, would seem to offer the best satisfaction for switch and crossing and similar planers. And that for ordinary work a table without binders, with V's of 100 or 110 degrees, and webs extending down either inside or outside of the bed and made a loose running fit would seem to be the most attractive machine to the prospective buyer.

# Small Arm Requirements for the British Army

Through the courtesy of the Pratt & Whitney Company we are enabled to publish below the requirements of the British war office in the matter of small arms. Accompanying the paper is a memorandum, reading as follows:

"I am to say that any rifle submitted for consideration under the above conditions should be addressed to the director of artillery and should reach the war office not later than May 1, 1910. The rifle should be accompanied by at least 300 rounds of ammunition for the purposes of a preliminary trial.

"Only rifles in a complete state will be accepted for trial; drawings, etc., unaccompanied by the rifle will not be considered.

"Should it be your intention to submit a rifle, it is desirable that an intimation as to date of delivery should be given."

## Conditions to Be Fulfilled by an Automatic Rifle

1. The rifle should be as simple, strong and compact as possible, and the mechanism should be well protected from the entrance of sand, rain, or dirt, and free from risk of derangement due to accident, long wear and tear, rough usage in active service, exposure to wet or sand, or fouling from long continued firing. It should be easily cleaned and inspected, and, if after long use any part breaks down, it should be easily and cheaply repaired. Such parts of the mechanism as require to be cleaned and oiled by the soldier should be capable of being stripped without the use of tools.

2. Filling the magazine and loading the cartridge into the chamber should be done with ease and certainty.

3. Cartridges may be rimless.

4. As regards the ballistics of the rifle, the range for a maximum hight of trajectory of 5¼ feet must not be less than 800 yards.

5. The weight of the bullet, which should be pointed, must not be less than 150 nor more than 180 grains.

6. The caliber must not be less than 0.27 inch, nor greater than 0.28 inch.

7. The working pressure must not exceed 21 tons to the square inch at 80 degrees Fahrenheit.

8. The rifle must be as light as possible, and, in any case, must not exceed 9½ pounds with magazine empty and without bayonet.

9. The rifle must be capable of being used either as an automatic-loading rifle, or as a magazine rifle, the change from one to the other being simply and rapidly effected. The rifle must work correctly as an automatic rifle, both with and without the bayonet fixed; the bayonet being attached to the fore end and not to the barrel. When used as a magazine rifle, the bolt or block must work freely by hand, without excessive force having to be used. The magazine must contain not less than five cartridges, and is to be filled either by means of a "charger," or a "clip." The rifle is to fire only one shot for each pressure of the trigger. After the last round in the magazine has been fired, the fact should be indicated by the bolt remaining open, or by some other conspicuous arrangement.

10. The direction in which the fired cases are ejected should be such as not to incommode the firer or men at his side.

11. The bolt or block supporting the base of the cartridge must at the moment of firing, be locked positively to the barrel, or to some part securely attached to the barrel, and must not depend merely on its inertia, on friction, or on the pressure of springs to resist separation of the breech bolt or block from the barrel on discharge; it must be impossible to fire the cartridge by pressing the trigger until the locking is complete.

12. An efficient safety device must be provided to prevent the rifle being fired when the safety device is used, and, on putting the safety device out of action, the rifle must remain cocked and ready for firing.

## Memorandum for Inventors

1. Instructions how to submit: Persons who desire to submit any invention for the consideration of the army council should do so by letter addressed to the secretary, War Office, London.

2. The letter should state the nature of the invention and give sufficient particulars to enable its merits to be fully considered, and adduce any evidence there may be of the usefulness of the invention obtained by actual previous experiment. Any drawings, models, or samples which it is desired to submit should either accompany the letter or be sent separately at the same time, or if bulky, particulars should be given as to the place at which the samples or models can be inspected if necessary. All designs, plans, drawings, models, samples, or papers submitted are at the owner's risk, and the department cannot accept any responsibility for damage to them should such occur.

3. Patented inventions: The letter should also state whether the invention is patented or provisionally protected in the United Kingdom, and if not patented or provisionally protected, the fact should be stated. If patented or provisionally protected, the number and date of the patent or provisional or complete specification should be quoted.

4. The attention of inventors is drawn to Section 29 of the "Patents and Designs Act, 1907," whereby it is enacted as follows: "A patent shall have to all intents the like effect as against His Majesty, the King, as it has against a subject. Provided that any government department may, by themselves, their agents, contractors, or others, at any time after the application, use the invention for the services of the Crown on such terms as may, either before or after the use thereof, be agreed on, with the approval of the treasury, between the department and the patentee, or, in default of agreement, as may be settled by the treasury after hearing all parties interested."

5. Terms: The letter should also state what remuneration or terms the inventor would ask if the army council should desire. (I) To acquire exclusive use of the invention. (II) To acquire unrestricted use of the invention in His Majesty's service, but also allowing the inventor a free hand to let others use it. If no remuneration is desired the fact should be stated.

6. Expenses: Expenses or loss of time incurred before or after the submission of an invention will give no claim unless authority for such expenses has been previously given by letter signed by the secretary or the assistant secretary of the war office, or by the director of artillery, and the liability will be strictly confined to the limits of expenditures authorized in such letter.

7. Should the army council consider it desirable to try an invention, the inventor will, as a general rule, be required to bear the expense of the provision of the article, its carriage, fitting up and removal, but the question whether such expenses shall in special cases be finally borne by the Crown or by the inventor, will be decided by the army council, according to the circumstances of the case.

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For the past few years the Geological Survey has been paying increased attention to the study of the peat deposits in the country which give promise of becoming an important fuel auxiliary in years to come. On a basis of $3 a ton it is estimated that the deposits represent $38,000,000,000 and an important fact that leads the investigators to look upon peat as a highly desirable fuel resource is that it is, as a rule, found in large quantities in regions far removed from the coalfields. In commenting on the prospective development of the industry, Professor Davis, in charge of the investigation, states that peat will have many uses besides producing power, heat or light. The by-products are of considerable value, including coke, illuminating oils, paraffin wax, phenol, asphalt, wood alcohol, acetic acid and combustible gases of good fuel value. If used for fuel gas there is enough nitrogen stored in the peat resources of the country to supply 644,000,000 tons with a value of $36,000,000,000 in addition to the gas. The future importance of the peat deposits is a growing factor.

# Portable Tools Electrically Driven

## Shapers, Planers, Drill Presses, Special Combination and Ball Socket Boring Machines as Portable Tools. Five Machines on One Casting

BY S. R. STONE

It was not very many years ago that a lecturer, discussing certain features of machine-shop practice before a body of technical students, made the following statement: "The demand for portable electric tools has led many people to place such tools on the market within the last year or two. These are, sometimes, indifferent tools from a mechanical point of view; indeed, it seems that the designers have not hitherto combined the requisite mechanical and electrical knowledge, although in most cases failure on the electrical side of the design has been most conspicuous."

How far conditions have changed, and with what degree of efficiency portable tools are now operated, may be gathered from a visit to any of the larger machinery-building plants in the country, where the modern flexible system of bringing the tool to the work, rather than depending entirely upon stationary tools, has been put in practice.

In the statement quoted above there is much food for thought. It not only declared, at the time it was made, what was generally known to be a fact, that portable tools were lacking in mechanical efficiency, but also gave the reason, viz., that the designers of such tools had not been able to apply the proper methods of electrical operation and control, without which the essential purposes of the new system were practically rendered nugatory.

The same was true, although in less measure, of pneumatically operated tools, and advances made during the past few years in the design of portable machines of this character have been scarcely less noteworthy; but for the present we will confine our attention to electrically driven tools. Since the latter came into general use, the various problems presented to designers have been so successfully met that there is no longer any question as to the efficiency of this type of apparatus, particularly for large work.

Most important of all, however, are the economies effected, resulting in a reduction of shop costs, and the more accurate results obtainable from the simultaneous use of several tools upon a casting with only one setting. In the accompanying illustrations are shown types of modern portable tools, with motor drive, which are characteristic of the best practice.

### Groups of Portable Machines

In Fig. 1 are shown a number of portable drills, slotters and vertical boring bars arranged along a floor plate. This

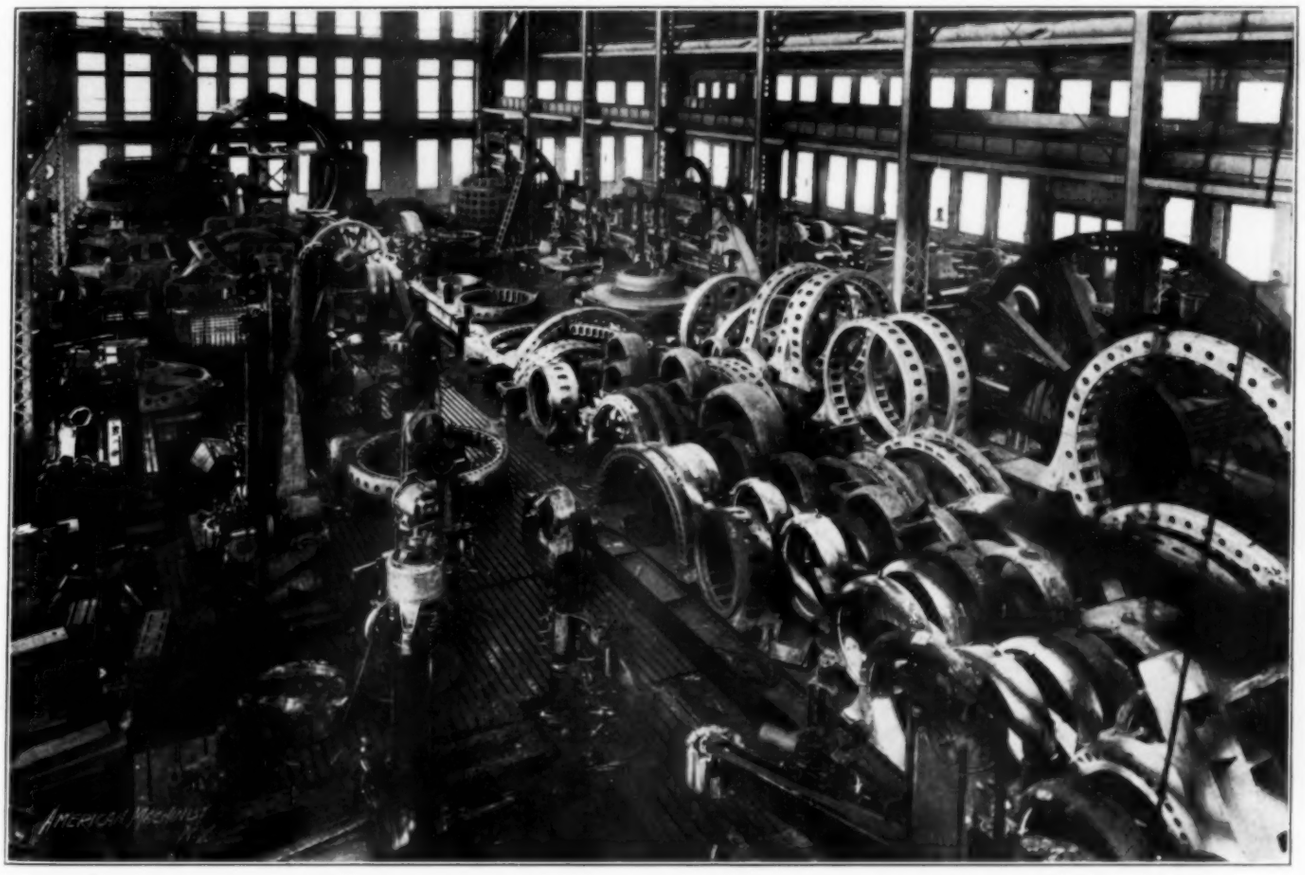

FIG. 1. SOME PORTABLE MACHINE TOOLS IN CINCINNATI SHOP OF ALLIS-CHALMERS COMPANY

view having been taken when the shop was not in operation, the character of the service is not displayed to advantage; but the number of large castings waiting to be worked on illustrates, graphically, how it is possible to concentrate, and dispose of, more quickly than with stationary tools, a great deal of work in one place. When each casting has been properly set and lined up on the floor plate, it need not, as a rule, be moved until all of the various operations are finished.

In Fig. 2 a group of portable drills are

working overtime on a rush job at the shipping end of the factory, the rest of the works being closed for a Saturday afternoon. This illustrates one of the advantages of portable tools, inasmuch as they can be concentrated in a single shop, or portion of a shop, when it is necessary to complete certain work outside of regular hours, thereby expediting the transfer of castings from one operation to another, and dispensing with more than one piece of apparatus for handling them.

In plants where the work travels from point to point over a large area and through separate buildings, the use of stationary tools in such an emergency requires keeping a much larger number of men, as well as cranes, in continuous service until the final operation for each shop has been performed. Moreover, it is possible with the tools in one group for one man to tend two or three machines, if desirable.

### Friction Driven Faceplate and Ball-socket Boring Machine

In the foreground of Fig. 3 may be seen a large faceplate, friction driven from an independent motor-operated arbor, with a portable tool at the left, showing the manner in which, while this enormous wheel is working on a 1500-kw. generator frame, one or more tools can be brought to perform other necessary operations on the opposite side, working either from the pit floor or on a temporary platform.

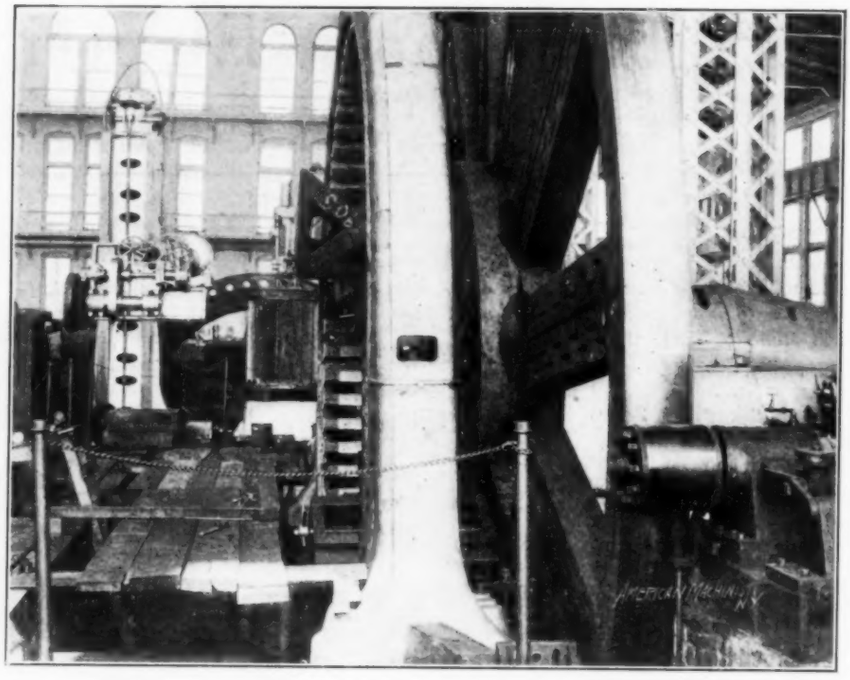

FIG. 3. FRICTION DRIVEN FACE PLATE WITH PORTABLE TOOL TO THE LEFT

In Fig. 4 is shown a Newton rotary planer or facing miller being used as a portable tool to face off an engine base.

By Fig. 5 are shown five large portable tools working simultaneously upon the bed and frame of a large Corliss engine, including a new type of horizontal drilling and boring machine now manufactured by Pawling & Harnischfeger, who are better known as crane builders, a

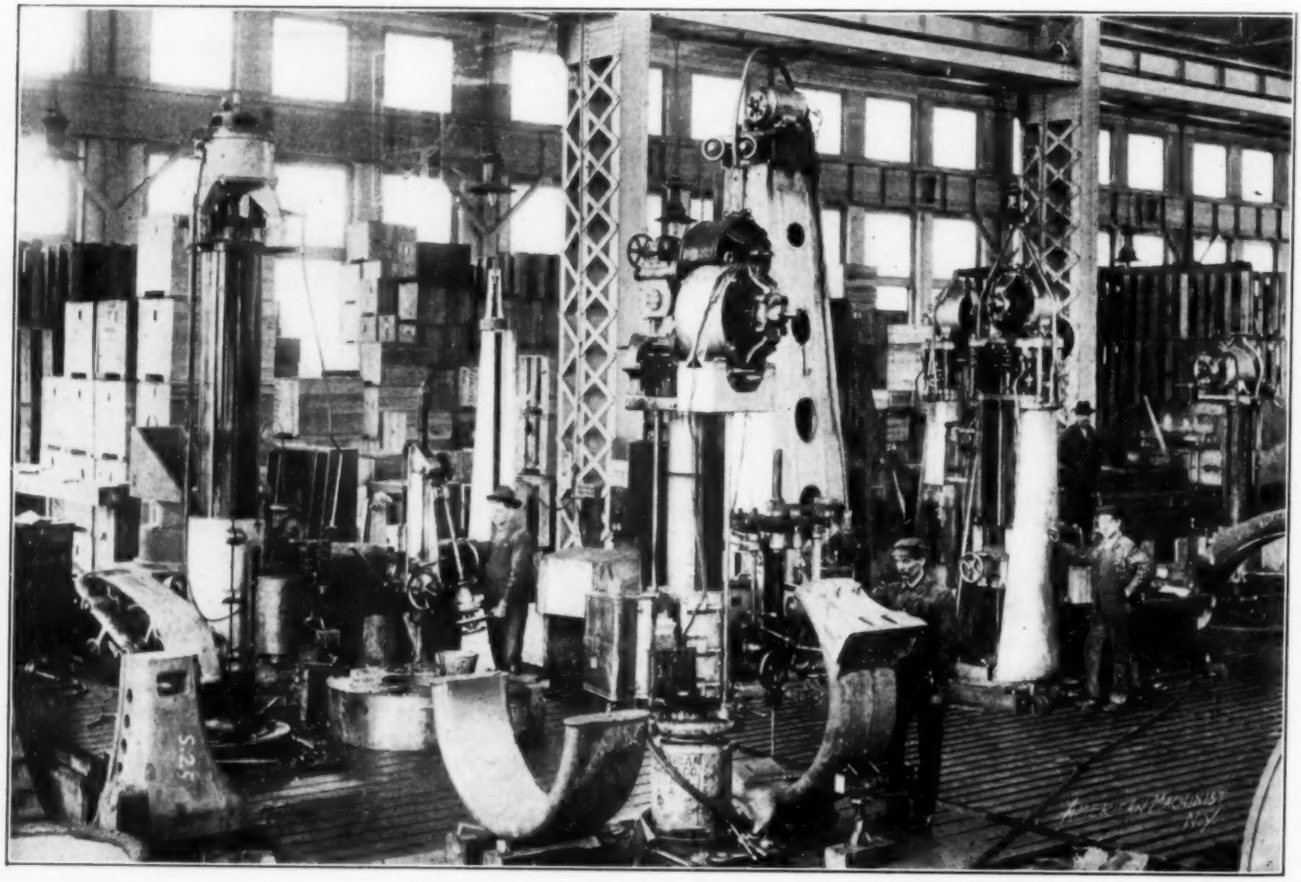

FIG. 2. GROUP OF PORTABLE DRILLS WORKING OVERTIME

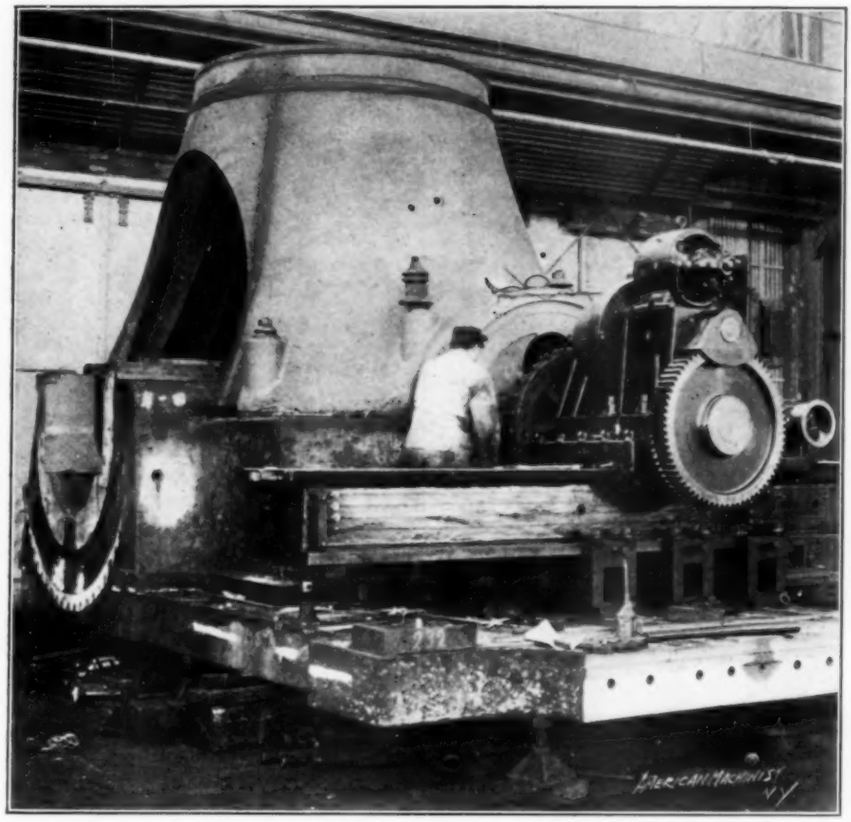

FIG. 4. A NEWTON ROTARY PLANER FACING OFF AN ENGINE BASE

Betts slotter, which may be used for finishing small surfaces in remote positions, two vertical Niles drills and a special ball-socket boring machine designed by the engine builders themselves.

The last named is a very interesting machine, and it is shown in detail in Figs. 6 and 7. It is used exclusively for boring the main bearings of large engines and simultaneously facing the ends. The boring bar is 12 feet 6 inches long, and 15 inches in diameter. It is belt driven from a motor secured to the floor plate, as shown in Fig. 7. This was originally developed as an emergency tool, to meet certain conditions of shop arrangement; but it proved so efficient it was continued in service. If redesigned, the method of driving could be improved.

### Five Machines Working on One Casting

The service performed by all five of the machines shown grouped around the engine frame would, from the size and shape of the casting, make rather awkward work for stationary tools and call for two or three helpers, besides requiring not less than the aggregate number of hours represented by the setting and operation of the several tools, the transportation of the piece from one to another and other delays incident to changing.

There is also the advantage of insuring that all of the work is in line, that the foreman's instructions are given at practically the same time to a group of machinists interested in the same piece, making each one a check upon the others, and that it enables him to devote more effective supervision to the work. Furthermore, there cannot be the same risk of spoiling a casting from inaccurate setting, slipping, etc., that there is in successive operations. The various contrivances used with stationary tools, for reaching distant parts of a piece, such as extension arms on cross rails, are also avoided, and there is no need of inefficient makeshifts

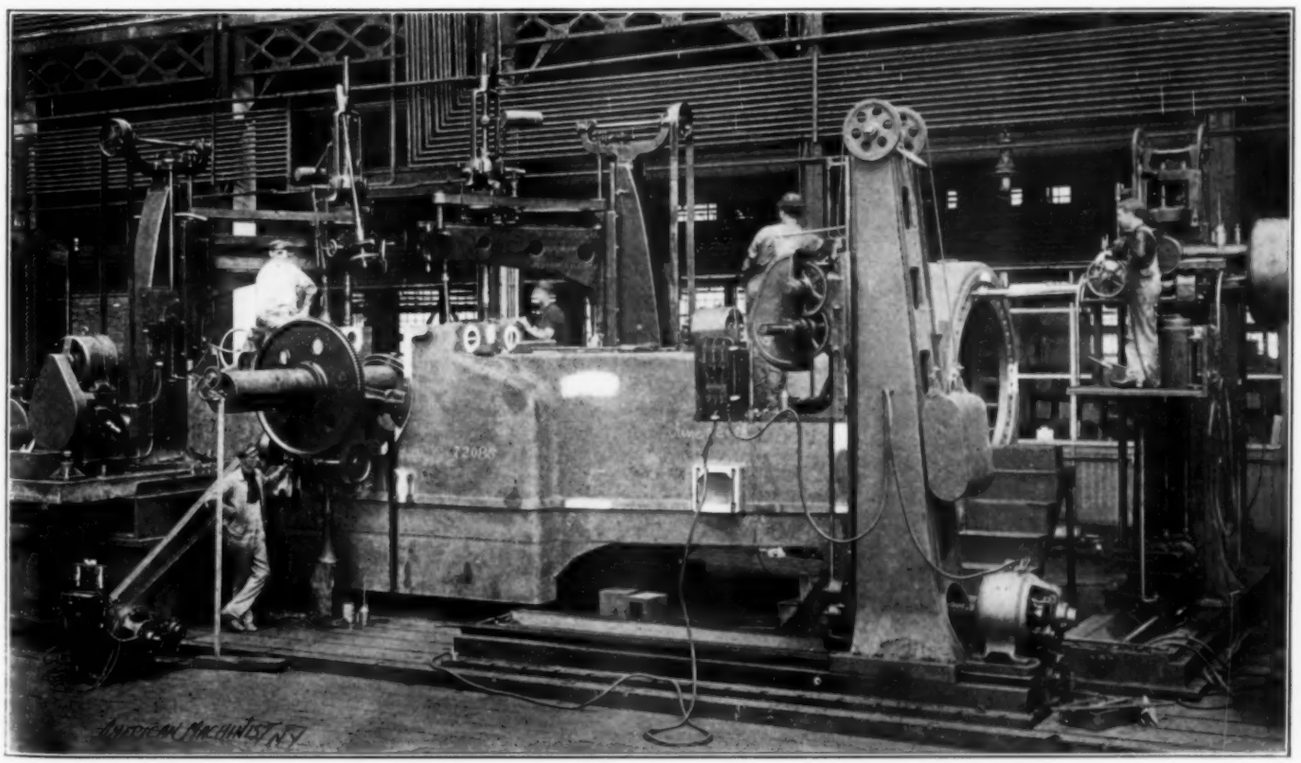

FIG. 5. FIVE PORTABLE MACHINE TOOLS AT WORK ON ONE ENGINE BED

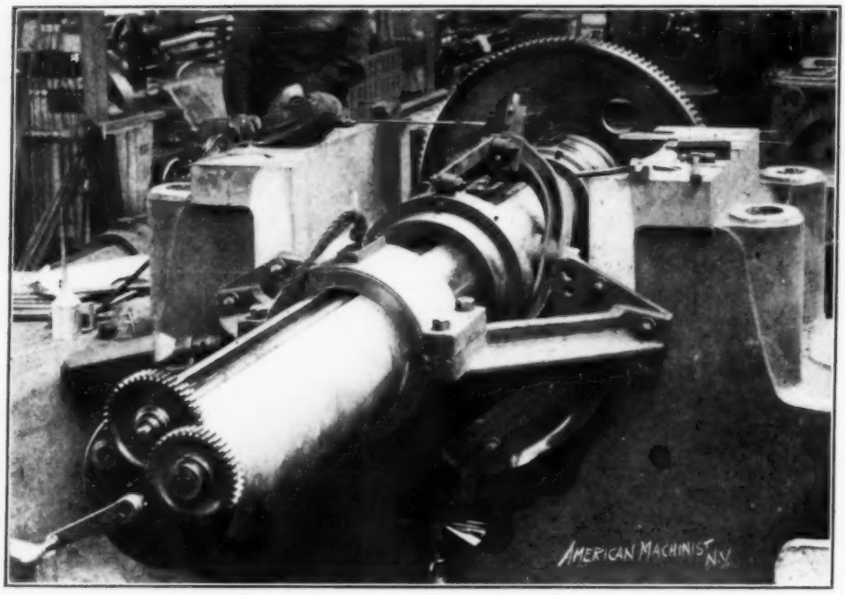


FIG. 6. BALL SOCKET BORING MACHINE

and milling machine, built by the Niles Tool Works, which is used in some of the larger engine-building plants of the country. Its general features of construction

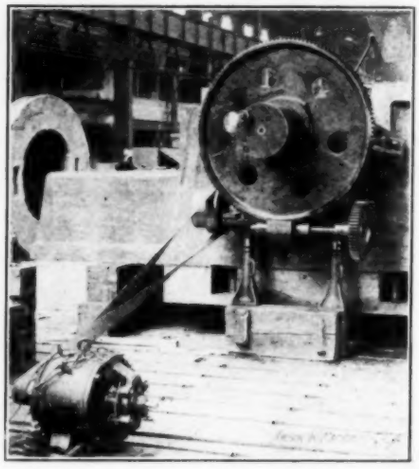

FIG. 7. METHOD OF DRIVING BALL SOCKET MACHINE

such as a boring bar operated from the extreme ends of such arms.

The heavier stationary machines, like planers, boring mills and turret lathes, can be reserved for the heavy, long-time operations in which their maximum economy is attained. The saving effected in recent years by the use, for example, of portable boring bars in place of boring mills for service that the former can just as well take care of, would show a truly staggering sum if it could be figured out. Portable shapers and slotters are now performing, in a veritable minimum of time, operations which it formerly took large and expensive stationary tools many hours to complete, while the light milling machine has displaced innumerable heavy planers.

### Special Combination Machine

Latterly there have come to the front a number of ingenious types of combination tools or special machines which perform more than one character of service. Such a machine of the 20-inch size is shown in Figs. 8 and 9 ready to work upon the low-pressure end of a steam-turbine cylinder. In Fig. 10 is shown a 50-inch stationary machine as it is working upon the frame of a heavy-duty engine. This type represents a portable facing, boring, drilling may be plainly seen from the illustrations.

The machines are set up ready for facing but they also have attachments for boring, drilling and milling, and may be used to especial advantage for work which is too large or of too odd shape to be conveniently handled by standard machines. At one setting various parts of the work may be faced, milled, drilled, bored and even tapped. When provided with rotary tables, the machines are particularly adapted to boring holes which are at fixed angles, in addition to finishing surfaces as shown in the illustrations.

For the larger sizes it is more convenient to secure this machine to a concrete

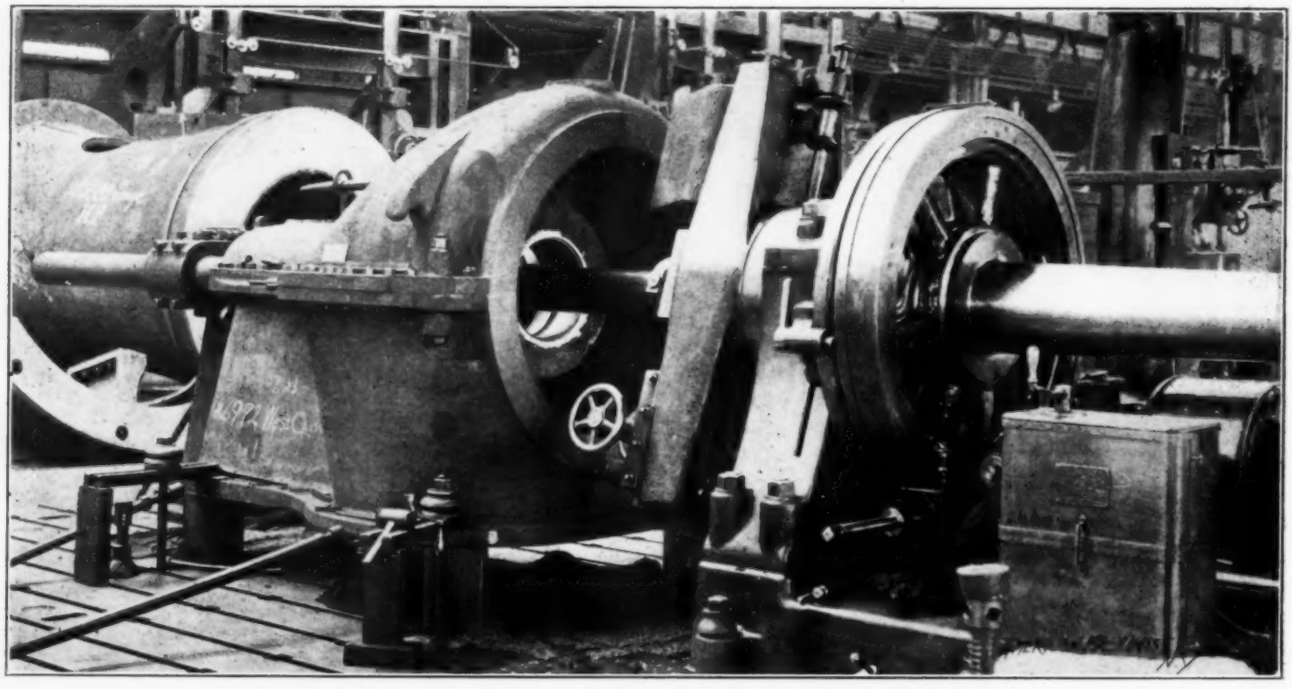

FIG. 8. SPECIAL PORTABLE MACHINE FOR FACING, BORING, DRILLING AND MILLING

foundation and use it as a stationary tool, as illustrated by Fig. 10; but it will be seen that in Figs. 8 and 9 it is merely bolted to the floor plate and can be moved about at will.

### Combination Machine as Improved

Two types of these machines of even more modern construction than those shown, and differing considerably in appearance, are now built. Each has a heavy column on which a spindle can be quickly adjusted at any desired hight, but in the first type the column has both rapid traverse and slow milling feeds along one side of a floor plate, while in the second type the column is stationary and a traversing table moves the work under the spindle.

The saddles have large bearings on the columns, are counterweighted and are raised and lowered by hand and power

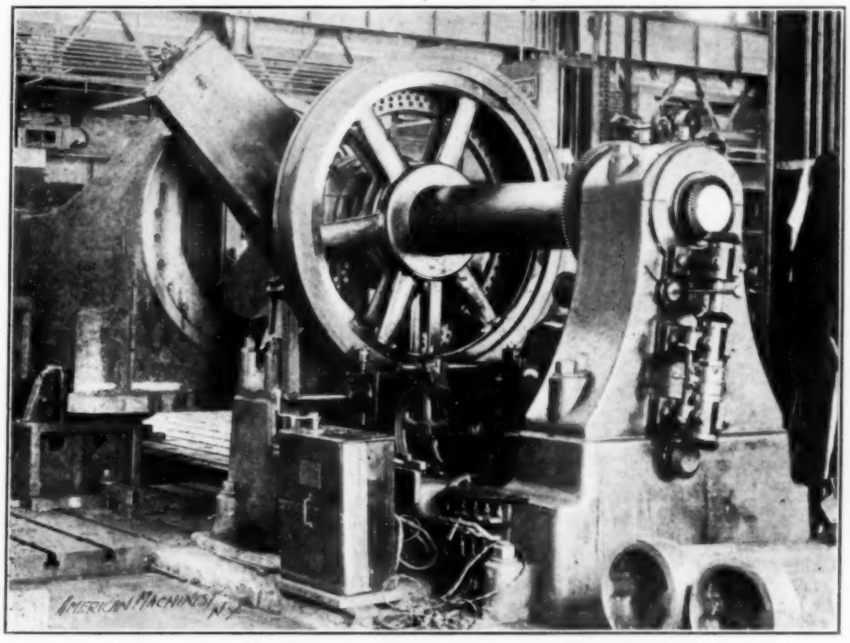

FIG. 10. A 50-INCH MACHINE ON CONCRETE FOUNDATION BESIDE FLOOR PLATE

and have power milling feeds. The spindles have power feeds suitable for the requirements of boring and drilling, as well as rapid and fine hand adjustment. All the movements of feeds and rapid traversing in the machines are controlled from one position, thus enabling the operator to handle the machine most easily and quickly. Out-board bearings, boring bars, screw-cutting attachments for spindles, and either hand or power rotating tables, are furnished with the machines.

### Some Big Tools. Comparative Costs

One of the largest portable tools is the rotary twin planer that was described on page 979, Part 1, Vol. 31, of the American Machinist. Another noteworthy machine is the large motor-driven draw-cut shaper, with motor-driven air compressor and storage tank directly attached, which has been worked simultaneously with three other machines on a single casting. This, with its development from an earlier design, will be described in a later article.

That portable electric tools are less costly, require a smaller amount yearly for maintenance and effect a large saving in floor space are additional considerations to be borne in mind, as well as the fact that crane service, both for transporting castings and holding them in position for machining (as sometimes required under the old methods), is greatly reduced. From whichever standpoint the subject is considered, the advantages of the new system are undeniable.

### Variable Speed

In the operation of shunt-wound motors for the individual driving of machine tools, under which classification portable tools ordinarily come, variable speed is one of the requisites of shop economy. Of the several systems used for electrical control and change of speed, all depend upon three factors, viz.: the number of conductors in series on the armature, the strength of the magnetic field and the voltage impressed upon the armature terminals. An increase in speed is brought about by a decrease in the number of armature conductors, a decrease in the strength of the magnetic field or an increase in voltage at the armature terminals.

One of the methods earlier used, which may be held as partially responsible for conclusions such as that quoted at the beginning of this article, was a change in the number of armature conductors, requiring a motor with two commutators and the use of a complicated controller. This arrangement proved unsatisfactory, being generally inefficient and too expensive. The methods now in common use involve a variation of the strength of the magnetic field alone or in combination with two, three or six voltages impressed on the armature terminals. These systems are termed single voltage, three-wire even voltage, three-wire unequal or multiple voltage and four-wire multiple voltage.

With the single-voltage system variation in speed of 1 to 3, and even 1 to 6, is successfully obtained.

### Three-wire Even Voltage

In the three-wire even voltage system two voltages are applied to the armature in combination with field weakening. The voltage between the outside wires is usually 240 volts, and between the middle wire and either outside wire it is 120 volts. By means of a suitable controller the armature terminals are connected to 120 volts with full field strength.

This gives the lowest speed of the motor, and from that point the speed is increased by field weakening through a range of 1 to 2. The controller then connects the armature terminals to 240 volts,

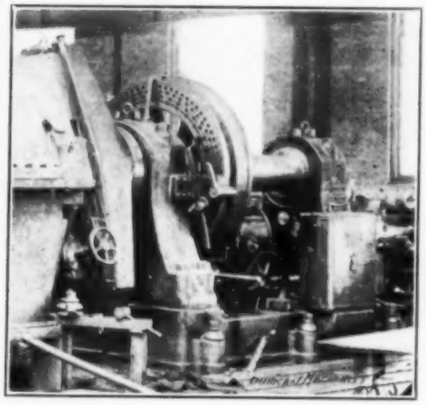

FIG. 9. ANOTHER VIEW OF SPECIAL PORTABLE MACHINE

with full field strength, and the speed is further increased by field weakening through a range of 2 to 4, so that the total speed range is 1 to 4.

Special controllers have also been brought out, of late, which still further increase the effectiveness of this system.

### Multiple Voltage

In the multiple-voltage system, patented by H. Ward Leonard, upon which all of the portable tools shown in the foregoing illustrations are operated, the armature is connected by means of a controller to three or more voltages in succession, and intermediate speed steps are obtained by field weakening.

In a straight multiple-voltage system, without field control, the motors are only worked up to their limit on the lowest speed, and by using shunt field control alone the motors are limited by their capacities at the highest speed; but, by properly combining multiple voltage and field control, the advantages of both systems

are obtained, and for the same speed range a given motor can be operated with greater output, thereby materially strengthening the efficiency of the tool and increasing its reliability for severe service.

The generator is operated on the two-wire system supplying the highest voltage, usually 250 volts, and on this voltage are operated the lighting system of the shop, the crane motors and such motors as require constant speed. For the variable-speed motors, it is divided into two other voltages, usually 90 and 160 volts, by means of a balancing transformer such as is shown in Figs. 11 and 12. This gives three voltages available at the motor driving the tool, viz.: 90, 160 and 250 volts, and proportional speeds are obtainable.

Controllers are so arranged as to introduce, in each instance, several steps of resistance into the circuit at the proper points, so as to obtain, for example, twelve speeds in the forward direction and nine in the reverse, the last steps being omitted in reversing. These speeds are so chosen that each one is approximately 20 per cent. higher than the one preceding, and suitable means are employed to ease the transition from one speed to another. This system is one which is very interesting to follow out, particularly after observing the operation of the portable tools shown in the accompanying illustrations.

### Transmitting Power to Portable Tools

In the plant at which some of the most interesting of the accompanying photographs were taken, a rather unusual feature of the electrical equipment is the use of alternating current transmitted from a central power plant to sub-stations in the various shops and thence distributed to the motors operating the tools. The choice of this system was considered advantageous for covering, with minimum loss, the spaces between buildings and the locating of the central station in relation to them.

The distances in this plant are much more considerable than usually found in establishments of the kind, the total acreage of the factory site being nearly 200 acres and the total floor and handling yard area approximately 74 acres. Some of the cable runs from the power house are about 3000 feet long.

In each of the shop units there is installed a 300-kilowatt rotary converter, such as that shown in Fig. 11, supplied through a bank of step-down transformers. From the direct-current end of this rotary converter, power at a potential of 220 volts is supplied by three-wire connections, through an electrical balancer, directly to the shop tools. A balancer of the standard type is shown at the right of the rotary converter in Fig. 11; a more detailed view of which is shown in the larger view Fig. 11.

### Size of Balancer

The size of the balancer required on a three-wire multiple voltage system is determined by the maximum amount of unbalanced load on either the 90- or 160-volt circuits referred to above (previous instalment), which must be sufficient to operate the largest motor load on either voltage, in which case each unit of the balancer has a capacity equal to 25 per cent. of the capacity of the largest motor when rated at 250 volts constant speed.

In the ordinary machine shops which have tools operated on this system, a large percentage of the tools are driven by motors varying in capacity from 2 to 20 horsepower. It has been found, under ordinary conditions of operation, that the larger the number of small motors the smaller will be the unbalanced load. For machine shops with fifty tools of various sizes driven by individual motors a balancer of 25-kilowatt capacity is sufficiently large to take care of any unbalanced load which may occur. This will operate one motor rated at 100 horsepower, 250 volts constant speed, which is as large as is ordinarily used on a machine tool.

In the shops specifically referred to above, the distribution of current from the central power house is all underground, in conduits with leaded-paper-insulated cables. In addition to having the buildings connected by 2300-volt, three-phase lines, the direct-current systems of the various buildings can be tied together, and direct current for the testing of large machines in the erecting shop fed into the direct current shop network. These tie-over connections also make it possible

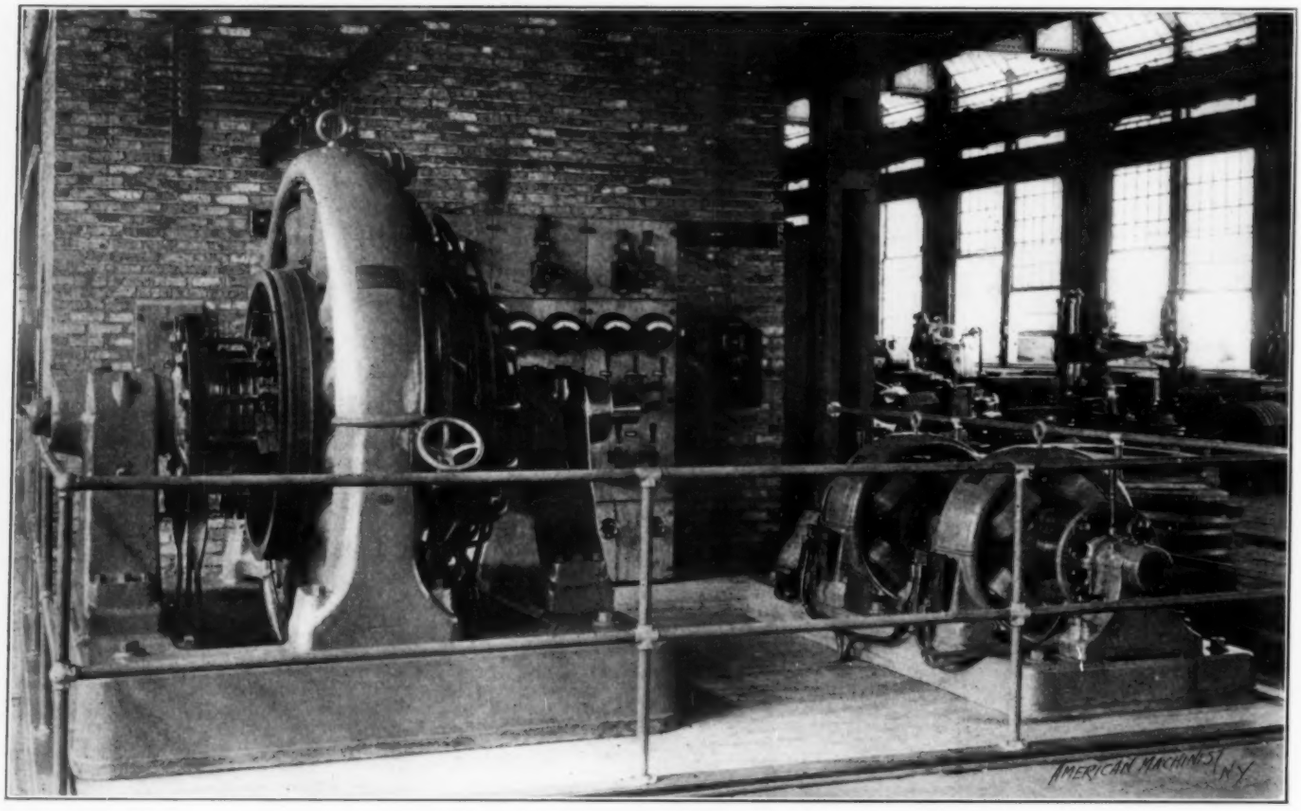


FIG. 11. ROTARY CONVERTER WITH BALANCER, FOR SPEED CONTROL FOR MACHINE TOOLS

to operate one shop without its sub-station, if it is running light or if its sub-station apparatus should break down.

### Conclusions

While portable tools of the smaller sizes have little or no gearing, its necessity for the larger machines is, of course, apparent. In most cases a large reduction to the speed of the motor will be found advisable, although not beyond a certain point, as the heavy slow-speed motors are not only expensive but also prove unwieldy for mounting on a portable tool. That feature of the subject has been discussed to such an extent as to require no further elaboration in this article.

In conclusion, however, it should be stated that, in selecting portable tools and arranging for their operation, both the mechanical and electrical efficiency of the motor-driven unit should have equally careful attention; while if compressed air is needed for the quick, positive actuation of any part, a light electrically operated compressor ought to accompany the tool, as piping air from a central point and using flexible tubing for connections seldom gives satisfactory results. In short, to secure the best economy, and to keep down costs, no single element of operation can be ignored.

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A report of the official investigation made upon the plans and safety of the new Manhattan bridge, New York, now in course of construction, and expected to be completed in a few months, has been filed with the bridge department, in which approval has been made of the plans and work thus far performed.

## Benefits of Science to the Hardener

By C. U. Scott

Using exact methods and instruments of precision in tool hardening and heat treatment of steel, and keeping accurate and full records of the same, will in the future be regarded as the most striking characteristics of the progress made in the mechanical line of today.

The general tendency at present is for more accurate methods, and as a result of these tendencies certain changes have already occurred, both in the manufacturing of steel and its treatment, as well as the men doing the work. One change is, that the mystery which at one time surrounded the hardening and heat treatment of steel, which was too often used as a cloak to ignorance, is fast disappearing. We now seldom hear of the great compounds and secret processes of our grandfather.

The line between ignorance and knowledge has been sharpened and we are able to see clearly where our efforts must be concentrated. We are fast approaching the place where we will not be obliged to draw from any source but facts. The habit of accurate observation teaches us to learn facts, and avoid surrounding our work with mystery or secret compounds that will penetrate steel while throwing off heat and that will intoxicate with innumerable qualities and strength.

As civilization advances witchcraft disappears, and so also do the men who are in possession of the mysteries and secret compounds, etc., for science has completely knocked their imaginary foundation out from under them and stands ready to offer knowledge, for a solid foundation, that is sufficient to meet the requirements of the times.

Of the unfavorable results of the accurate methods, the most prominent one is the tendency to use instruments of precision in place of skill and knowledge, instead of with them, as it is skill and brain behind the instruments which are the achieving forces. While it is true that accuracy is only a relative term and there is a limit of error both in the instrument and manipulator, we cannot hope to be accurate in everything but must be in some.

There is a tendency to keep the hardener away from the testing department, but this should not be. If the tests which are now given steel are not observed by the hardener, the final instructions are much more liable to be faulty. It should be not only the aim to train the hardener to do his own testing, but also to impress on him the necessity of becoming proficient enough to interpret the results obtained from the tests.

In the progress of science they have not only given us new methods and instruments for treating steel, but also new names, and the hardener who does not take them up and learn to digest them will, in a short time, be considered from the old school.

The scientist is not only making it possible for us to become masters of our art, but he is forcing it upon us and the more willing we are to become students, the sooner we will become masters. We have nothing to fear from his progress if we but adapt ourselves to his findings. The

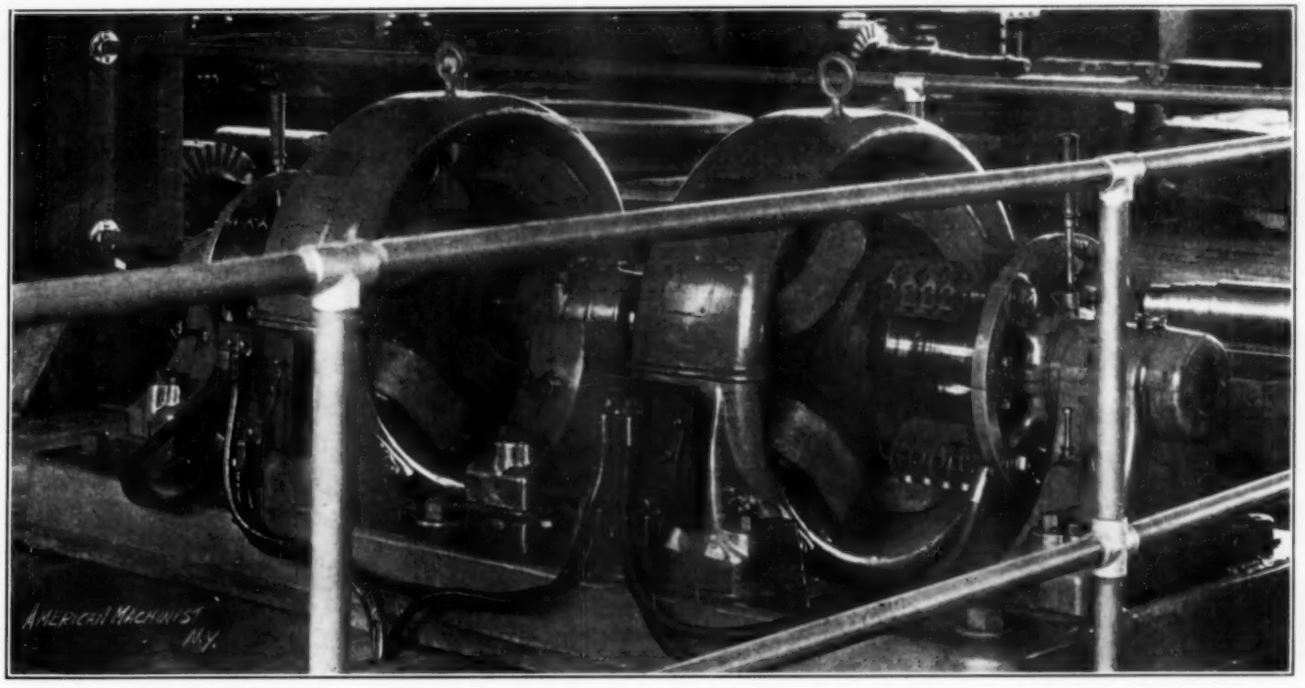



FIG. 12. LARGER VIEW OF BALANCER IN WEST ALLIS PLANT OF ALLIS-CHALMERS COMPANY

product of science cannot take from the hardener any of his former achievements, but it will and is placing before him the possibilities of making his department one of preciseness, and thus it must burst out of the smoke and mystery that have surrounded it for ages.

Will we be so stupid, so immovable as to not grasp with a mighty welcome the golden opportunities science has placed at our door? To do so we must accept the finding of our metallurgist, even to absorbing the new theory and names that are being applied to what we term carbon steel.

But a short time ago I wanted to quit hardening because I could see nothing in the future for it or myself, but now I see one of the brightest fields yet to be explored. I see where it is possible for me to become master of my work, a thing that was not possible to see until the scientist had tumbled over my house of deceit and was offering me a solid foundation, not built on mysteries or compounds.

In following the theories advanced by the metallurgist and scientist, I made some mistakes and expect to make more, but I improved my work in so doing. The articles appearing in the AMERICAN MACHINIST have been some of the greatest help. I have been able to take exceptions to some of the best articles that appeared, but in so doing have become convinced of a fact, and this is what we should all be looking for.

## The Machinery Trade and Opportunities for Developing it in Siberia

By ARCHIBALD J. WOLFE

Siberia, broadly speaking, embraces the vast possessions of Russia beyond the Ural mountains, excepting the Transcaucasian, Transcaspian and Turkestan regions, and is a territory that stretches from the Urals to the Pacific ocean, from the polar ocean to the frontiers of China. It is a country 25 times the size of Germany and peopled at a rough estimate by about 10,000,000 people. At the last census in 1900 the population was 7,894,258. About 75 per cent. of the population are Russians. Siberia has been compared with Canada, and the comparison may hold good if the northwestern portions of Canada are meant. Throngs of emigrants, all of them of the farming class, continually pour into Siberia from European Russia. The word "emigrant" is, perhaps, not very accurate, for the wanderers do not pass out of the confines of the Russian empire, but a vast farming population is steadily streaming into the land of boundless possibilities. Already Russian peasants in Siberia supply butter for the 5 o'clock tea tables in London.

### A GENERAL SURVEY

It is a country which combines every variety of temperature and climate. In the streets of Omsk camels are the beasts of burden, while in the north the reindeer is the recognized medium of transport.

The Siberian railway is a great thoroughfare, constructed at an enormous expense, and connecting the heart of Russia with the Pacific, making Siberia a neighbor of our own Pacific coast, connected rather than divided by means of the ocean. This stupendous enterprise has awakened Siberia and placed the country, formerly a *terra incognita* to the trade, into the position of a prominent and highly desirable customer.

Siberia is mainly an agricultural country, and mining is the second industry in importance. However, the prospect for a large import business, excepting in certain classes of machinery, is rather in the, perhaps not distant, future than the present. There are but few large cities, the population, when the size of the country is taken into consideration, is scant and diffused, and the British commissioner to Siberia, H. Cooke, finds that the expansion of imports will largely depend upon the increase in the welfare of the principal producer, the farmer. But the country has magnificent opportunities, is very rich, the railway is developing it and the immigration proceeds apace.

As far as the machinery trade is concerned, the building of the great railway, of the railway around the Baikal and various other enterprises, as well as the natural demand in a new country with a rapid increase of population, have brought about a natural expansion in machinery imports. Siberia itself is barren of industrial works; it lacks a laboring class for industrial enterprises, and Russian factories with better facilities, cheap labor and vast output supply Siberia's demands.

In the growth of agriculture the dairy industry and mining enterprises, all of which will be touched on in the course of this article, the United States has been a prominent purveyor of Siberian wants. Great Britain, although a prominent purchaser of Siberian butter, the exports of which reach about $15,000,000 per annum, lags far behind the United States in supplying the machinery and utensils used in these three great industries.

### AGRICULTURAL MACHINERY AND TRADE CONDITIONS

As far as agricultural machinery is concerned, some of the American manufacturers of this class of machinery early realized the importance of the market. The income and the profits derived from the butter industry enable the Siberian farmers to purchase expensive time- and labor-saving machinery. A few good harvests in succession always mean a boom in the imports of the best grade of expensive machines for agricultural purposes.

Both government depots and private firms maintain large stocks of American machinery and implements. The cream separators used in the butter industry are of Swedish origin, and butter is frequently given in payment for separators. The same firms in Siberia that sell agricultural machinery also export butter, and thus it has become customary in many instances to pay the dealer in butter for his agricultural implements. The Swedish cream-separator manufacturers have utilized this fact, and every butter-exporting office is also an advertising center for the Swedish products. Attractive posters in the Russian language and detailed literature, also in the vernacular, serve to popularize these goods. The sale of agricultural machinery proper, however, increases from day to day. New regions are continually reached, and fresh depots of American and Russian agricultural machinery are constantly erected, in many of the little towns there being 10 to 15 separate establishments vying for the farmer's demands. As far as western Siberia is concerned, therefore, it is the export of butter and the import of agricultural machinery that are the most striking features of commercial life.

Unfortunately there are no figures available showing Siberia's share in the Russian imports of machinery for agricultural and dairy purposes, including engines for threshers, steam plows and extra parts of machinery. A gradual and noteworthy increase of Siberia's share could be easily traced in these statistics.

Mr. Cooke, the British trade commissioner to Siberia in 1904, comments on the fact that, as far as agricultural machinery is concerned, the Americans have made the market their own and that the competition bears a rather inter-American than international character. The openings for the further application of agricultural machinery, however, are so vast that it behooves even the enterprising American exporter of agricultural machinery to keep his eye on the country, for there are still plenty of regions, such as those around Tobolsk and Tiumen, where the primitive plow is still in evidence and no sign of modern machinery is seen.

### GOVERNMENT DEPOTS

The trade in machinery is to a large extent in the hands of government agricultural depots. These are official organizations with a commercial character. They pay duty on their imports, but enjoy a freight reduction on the Siberian line east from a certain point. They grant credit to peasants, but their accounts have precedence before all others in the collection. Of course, the government depots have no rent to pay and they are in many ways favored above private organizations. Still these organizations are far from having the monopoly of the trade, for they stick to hard and fast prices, whereas private firms are more reasonable, and in many instances the peasants prefer to deal with the latter. Of the agricultural imple-

ments, mowers and rakes sell in Siberia at from 120 rubles to 165 rubles ($60 to $82.50), reapers at about $100, binders at $180 to $212.50. Threshers, mostly of Russian origin, sell at $100 to $350. A thresher factory was started in Omsk, Siberia, in 1904.

There is an increasing demand for steam engines, but the British and the Germans seem to have got ahead of the Americans in this respect. There was at first a prejudice against steam power in agricultural operations, and it behooves American manufacturers to step in and dissipate it.

### Gold Mining

Next in importance to the dairy industry (in which for some unaccountable reason American manufacturers have thoroughly neglected opportunities of pushing their machinery) and agricultural pursuits, stands the Siberian gold industry, which is passing from the manual stage into the more advanced period of using mining machinery. There is plenty of gold in alluvial deposits, waiting capital, science, system, and quartz mining is also beginning to attract attention. Pumping, hydraulic, steam appliances, gold-mining machinery and supplies of every description are among articles for which there should be an increasing demand in Siberia. Expensive machines are at work already, costing from $30,000 to $50,000. These were supplied by the British. The Americans have a splendid chance to investigate this field and to supply the demand from the Pacific coast. The gold industry, though promising, suffers from the lack of a sufficient labor supply. Gold mining in Siberia is free to all, Russians and foreigners, with a few restrictions, which are neither important nor irksome. There are smelting establishments in Irkutsk, Tomsk, Krasnoyarsk and elsewhere.

The dredgers used in Siberia are mostly of the New Zealand type, with a few built by the famous Putiloff works in Russia. The price of the British dredgers delivered at the destination and set up is from 60,000 to 100,000 rubles, whereas the Russian dredger delivered at destination costs about 55,000 to 80,000 rubles. Gold-mining machinery and appliances for Siberia are not subject to duties. Of interest may be the figures given by Mr. Cooke for the cost and freight of a New Zealand dredger set up in Mariinsk:

| | |
|---|---|
| Cost of dredger in New Zealand | $16,300 |
| London-made steam engine and boiler | 3,500 |
| Centrifugal pump | 150 |
| Cables and belting | 500 |
| Freight New Zealand-St. Petersburg | 1,000 |
| London-St. Petersburg | 200 |
| St. Petersburg-Mariinsk | 2,000 |
| Mariinsk to mine | 1,150 |

In addition to dredgers, excavators and machinery of this class, there is an increasing demand for engines, boilers, pumps, steam launches, steel cables, belting, tools and instruments of every description for the Siberian gold industry. The cities of Tomsk, Krasnoyarsk and Irkutsk should be visited by representatives of the firms desiring to enter this trade. San Francisco firms are particularly well placed to compete for supplying the wants of the industry in the Amur and Zea districts. No dredgers are in use there, but the time is more than ripe for them.

Besides gold, Siberia produces silver, lead and copper, as well as iron, coal and graphite. In the territory of Akmolinsk, there is a large copper-smelting plant, founded by a Russian firm, but recently reported to have been sold to the English, who have done a great deal for the development of mining in Siberia. The iron industry in Siberia, however, is somewhat of a failure. There are five iron works, most of which have been run at a loss. The works of the East Siberian Metallurgical and Mechanical Works Company were founded under big auspices and had an initial order for over eleven million rubles' worth or rails, but they became involved in a gigantic financial crash; still some wealthy company may be formed and revive this particular enterprise. The other works have also had a somewhat chequered existence.

### Local Industries

With the exception of agriculture, dairying and mining, the prospect for much trade in machinery with Siberia, of course, is problematic. The country has no manufacturing industry, excepting on a very small scale—of the cottage-workshop type—due the scant culture and scattered character of the population, the lack of skilled hands, and the small demand for manufactured goods of local character. The industrial enterprises in the manufacturing line are very small, including small flour mills (with a somewhat increasing demand for machinery), dairies, distilleries and tanneries. "The imperfect data of our industrial statistics," writes a Russian authority, "confirm the opinion as to the hopelessness of the more complicated branches of manufacturing industry."

At various places along the railway, particularly at Krasnoyarsk, are established large government mechanical and repairing works, excellently equipped with the most up-to-date machine tools and appliances, the Krasnoyarsk shops employing 2000 hands. A firm in Tiumen builds river steamers and engines, but on the whole machine shops are small and are principally engaged in repair work for agricultural implements.

### Reasons for Germany's Success

Of some interest are Mr. Cooke's remarks on the proportion of various countries' trade in general machinery imported into Siberia:

In Siberia proper Germany has the larger share of the general machinery market, apart from the agricultural, though it is rivaled by the United States and Great Britain in the far eastern ports. The chief causes of the German predominance would seem to be:

First and foremost, superior cheapness, an attribute indispensable in Siberia.

Lightness and general correspondence of the goods with the requirements.

Easier facilities offered, and especially easier credit terms.

Superior accessibility on the part of the German makers, greater activity in pushing their goods, willingness to accept business, no matter how small, as well as to meet all possible suggestions and adaptations.

The presence of German resident firms and business men, and periodical visits of representatives, consequently closer knowledge of the market.

The greater currency of their language in business circles, the practical nature of their catalogs, price lists and terms, the facilities they offer, and in general their undoubtedly superior knowledge of the country and its business customs and ways.

In conclusion we may mention a few of the industries which are of the most immediate promise: Steam flour mills are starting throughout Siberia and American machinery should be pushed and could be introduced. Sawmills are being set up with frames from Riga, engines from Finland and German saws, and the Americans could supply the demand. The Germans also supply printing machinery, brickmaking machinery, pumps, etc.

The best method of advertising in Siberia is by means of loose sheets in the Russian language, but if not in Russian then at least in German. Russian weights should be given throughout.

## Method of Hardening High Speed Steel

By L. E. Stephens

The following recipe for hardening Novo high-speed steel I have tried thoroughly and found it to work well. We have had more or less difficulty, continuously, in making tools that would withstand some of the severe tests to which it has been necessary to put them. One of these is turning plow-steel casing shoes for oil-well tools.

The tools tempered in the following way are standing fully twice the service of those that were hardened by any other method we have tried. We heat the tool, rather slowly, almost to the melting point, then apply prussiate of potash, the same as for case-hardening, for about 15 seconds and plunge in boiled linseed oil, keeping there until cool.

An amusing example of incessant motion together with continual change of center of gravity and specific gravity combined may be seen on immersing a grape in a glass of soda water.

# Compressed Air Calculation Short Cuts

## A Chart by Which M. E. P. and Horsepower May Be Determined without Use of Complicated Formulas Involving Fractional Exponents

## EDITORIAL CORRESPONDENCE

In some of the late issues of the AMERICAN MACHINIST a number of articles have been presented giving curves and tables to assist in the somewhat complicated calculations relating to the compression of air. Genuine "short cuts" for such calculations as these are rare, and for this reason it is a pleasure to present the accompanying diagram, which was calculated by Ward Raymond, who is assistant chief engineer at the Phillipsburg, N. J., plant of the Ingersoll-Rand Company. By the use of this diagram the calculations of the adiabatic mean effective pressure and indicated horsepower developed by the compression of air are reduced to their simplest possible terms.

In this diagram we have the solution of the expression

$$MEP = 3.46\, P_1\, (R^{0.29} - 1).$$

$MEP$ refers to mean effective pressure developed in the air cylinders; $P_1$ is the absolute initial pressure, which in the case of an air compressor is usually atmospheric; $R$ is the ratio of compression, or the absolute discharge pressure divided by the absolute initial pressure. Owing to the fact that this formula contains a decimal exponent, namely, the 0.29 power, it is rather unwieldy, and many people shrink from using it any oftener than they can possibly help. Knowing the value of $R$ from the conditions of the problem, we find directly from the diagram the corresponding value of the rest of the expression, namely, $3.46\ (R^{0.29} - 1)$, and multiplying this factor by the absolute initial pressure, gives the mean effective pressure right away. The four following examples will serve to show the simplicity of the operation:

1. Assume single-stage compression from the atmosphere to 60 pounds gage pressure. $R$, the ratio of compression, will be $(60 + 14.7) \div 14.7$, or $74.7 \div 14.7 = 5.08$. Examining the diagram we find that the vertical line marked $A$ corresponds to the value of $R = 5.08$. From the curve at this point we find that the value of the factor for which we are looking is 2.082. In the case of the problem the initial pressure is atmospheric, or 14.7 pounds per square inch absolute. Multiplying 2.082 by 14.7 we have a mean effective pressure developed in the air-compressor cylinder of 30.6 pounds per square inch, based on adiabatic compression. This is the true theoretical adiabatic $MEP$ exerted against the piston and it is not necessary to deduct the back pressure from this as in the case of the usual steam formula.

In most compressed-air problems the mean effective pressure is not wanted so often as the indicated horsepower per 100 cubic feet piston displacement per minute, and in all cases this can be found by dividing the mean effective pressure by 2.29. For the case in point, dividing 30.6 by 2.29, we have 13.4 indicated horsepower developed in the air cylinder per 100 cubic feet of piston displacement per minute. Dividing this by 100 and multiplying by the piston displacement per minute of the compressor, we have the total indicated horsepower in the air cylinder in question.

2. If the compression had been single-stage from atmosphere to 100 pounds the value of $R$ would be

$$114.7 \div 14.7 = 7.81.$$

In looking at the diagram we find that the vertical line corresponding to $R = 7.81$, crosses the line of the diagram at the point marked $B$ corresponding to a value of the factor 2.82. Multiplying this number by the initial pressure 14.7 pounds absolute, we have an answer of 41.4 pounds per square inch $MEP$ developed in the air cylinder. Again, dividing this by 2.29 we have 18.1 indicated horsepower developed per 100 cubic feet of piston displacement per minute.

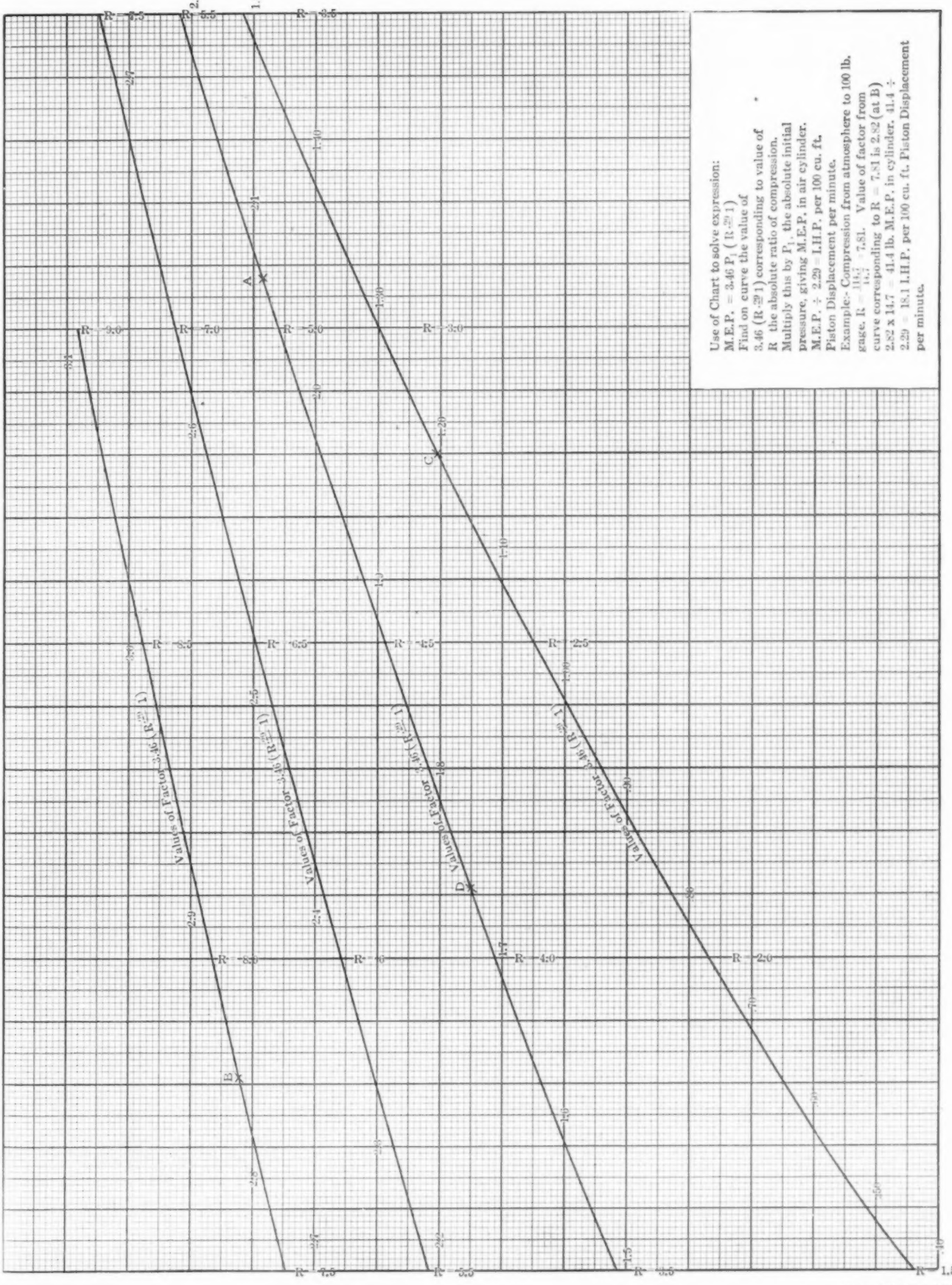
3. For compound compression all we have to do is to remember that with theoretical conditions the horsepower of the low-pressure and the high-pressure cylinders should be alike, giving the minimum total power developed. In practice air compressors are designed so that this is approximately true. The curves and all the formulas are, of course, based on the theoretical adiabatic, and, therefore, we are correct in assuming that the horsepowers in each of the two stages of compression are alike. If the horsepowers are alike this means that the ratios of compression in the two stages are also alike, and consequently the ratio of compression in each cylinder for compound compression will be the square root of the total ratio of compression.

From atmosphere to 100 pounds pressure we have already found that the total ratio of compression is 7.81. The square root of this or the ratio of compression in either the low-pressure or the high-pressure cylinder is 2.8. Entering the diagram we find that the line corresponding to the value of $R = 2.8$ crosses the factor line in the diagram at the point marked $C$ and corresponds to the value of the factor 1.204. Multiplying 1.204 by the initial pressure 14.7, we have the mean effective pressure in the low-pressure cylinder 17.7 pounds per square inch. Dividing 17.7 by 2.29, we have the power in the low-pressure cylinder 7.73 indicated horsepower per 100 cubic feet of displacement of this low-pressure cylinder. As this must be half of the total compressor horsepower of the compound compression, we have 15.46 indicated horsepower total for the two stages per 100 cubic feet of displacement per minute. Dividing this by 100 and multiplying by the low-pressure cylinder displacement in cubic feet per minute we would have the indicated horsepower of the compressor in question.

This process may be carried through three, four, five or any number of stages of compression. All that needs to be remembered is that for multiple-stage compression the horsepower in all the cylinders is supposed to be alike; therefore finding the horsepower in the low-pressure cylinder we can multiply this by the number of stages or cylinders, giving us the total horsepower of the compressor. In order that the horsepowers shall be alike, the ratios of compression in the various stages must be alike and consequently for compound compression, must be equal to the square root; for three-stage the cube root and for four-stage the fourth root of the total ratio of compression.

4. Assume three-stage compression to 1000 pounds pressure. The value of $R$, the ratio of compression, will be 1014.7 divided by 14.7 or 69.2 compressions. With equal horsepower in each stage the ratio of compression in each stage and consequently in the low-pressure cylinder, will be the cube root of 69.2, or 4.11, and in the diagram we find that the value of $R$ corresponding to 4.11 is marked $D$. This corresponds to the value of the factor of 1.75. Multiplying 1.75 by 14.7 we have 25.7 pounds per square inch mean effective pressure in the low-pressure cylinder. Dividing this by 2.29 we have 11.22 indicated horsepower per 100 cubic feet per minute displacement of the low-pressure cylinder.

This is the horsepower in the first stage, also in each of the succeeding stages; consequently multiplying this figure by the number of stages, namely, three, we have a total horsepower of the compressor of 33.7 indicated horsepower per 100 cubic feet piston displacement of the low-pressure cylinder of the compressor per minute. This divided by 100 and multiplied by the piston displacement of the low-pressure cylinder per minute will give the total horsepower of the compressor.


Use of Chart to solve expression:
M.E.P. = 3.46 $P_1$ ( R $^{1.29}$ 1)
Find on curve the value of
3.46 (R $^{1.29}$ 1) corresponding to value of
R the absolute ratio of compression.
Multiply this by $P_1$, the absolute initial
pressure, giving M.E.P. in air cylinder.
M.E.P. ÷ 2.29 = I.H.P. per 100 cu. ft.
Piston Displacement per minute.
Example:- Compression from atmosphere to 100 lb.
gage, R = 114.7 ÷ 14.7 = 7.81. Value of factor from
curve corresponding to R = 7.81 is 2.82 (at B)
2.82 x 14.7 = 41.4 lb. M.E.P. in cylinder. 41.4 ÷
2.29 = 18.1 I.H.P. per 100 cu. ft. Piston Displacement
per minute.
A
B
C
D
Values of Factor 3.46 (R $^{1.29}$ 1)
Values of Factor 3.46 (R $^{1.29}$ 1)
Values of Factor 3.46 (R $^{1.29}$ 1)
Values of Factor 3.46 (R $^{1.29}$ 1)
American Machinist, N.Y.

WARD RAYMOND'S CHART FOR DERIVING MEAN EFFECTIVE PRESSURES FOR ADIABATIC COMPRESSION OF AIR FROM ANY INTAKE PRESSURE

A little practice with the use of this diagram will show its value for all kinds of special horsepower and mean effective pressure problems. It can be used for compression from initial pressures other than atmospheric, by the same process, simply finding the ratio of compression by dividing the absolute discharge pressure by the absolute initial pressure, whatever that may be. It must always be remembered that the mean effective pressure is obtained for any one cylinder by multiplying the factor obtained from the curve by the absolute initial pressure of that particular cylinder. The indicated horsepower per 100 cubic feet obtained from this is always for the actual piston displacement of the cylinder in question, no matter what the pressure of air may be.

The curves may also be used for working backward, that is to find various pressures, compression between which will give a certain desired horsepower. In fact the flexibility of the diagram grows with continued use. The results obtained are closer than a slide rule will read and more than this would be hairsplitting.

S. B. R.

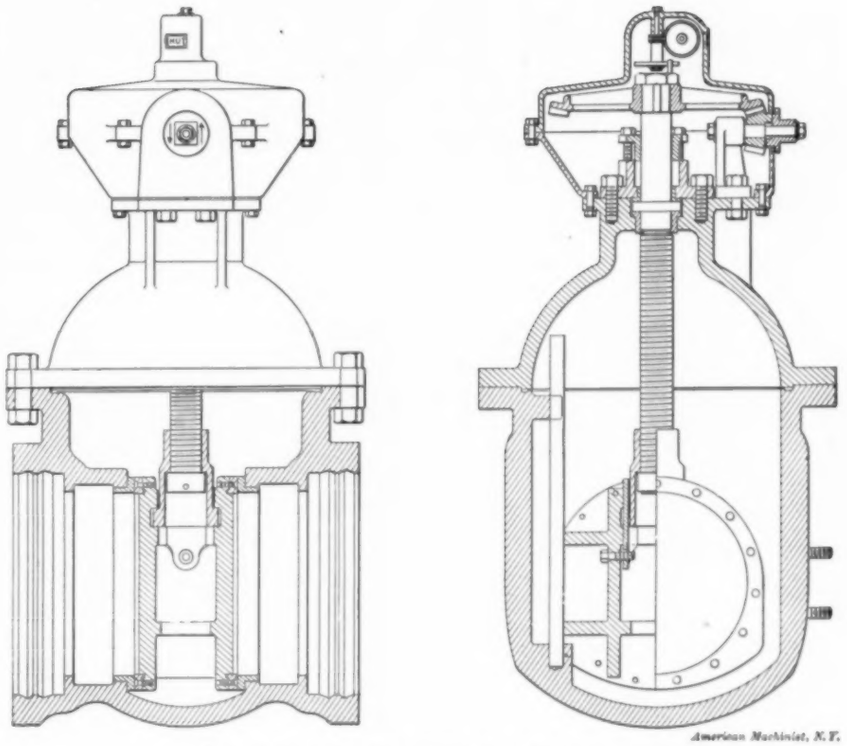



FIG 2. 16-INCH PELTON HIGH-PRESSURE HORIZONTAL GATE VALVE

## High Pressure Gate Valves for Auxiliary Salt Water System for San Francisco

By Geo. J. Henry, Jr.*

The plans, and indeed the installation of the pipe lines, pumping stations and accessory equipment for the system of piping for the high-pressure fire protection system is reported as progressing rapidly, and the valves, 2790 in number, are being manufactured and designed by the Pelton Water Wheel Company, of San Francisco.

The design is original and unique and is, of course, made up to meet the particular requirements of this service.

All valves are of the bell and spigot type. This bell is of special form determined experimentally and giving the greatest security and permanence against earth displacement, varying pressure and prolonged action under salt water. The valves are scheduled according to size as follows: 1200 8-inch, 250 10-inch, 640 12-inch, 310 14-inch, 70 16-inch, 200 18-inch and 60 20-inch.

All valves are to be tested to 650 pounds cold-water pressure and will work under 325 pounds during fire service. They are all of the parallel, double-disk, Pelton type, with Tobin bronze stems and the valves above 10-inch will be provided with manganese-bronze gears. The 12- and 14-inch sizes are each provided with 3-inch bypasses of the same type, and the 16-, 18- and 20-inch sizes are each fitted with a 4-inch bypass.

The fire department will carry but one wrench, fitting all valves and bypasses and all gates can be easily opened under full pressure by one man. The highest grade of material and workmanship will be employed throughout and this type of fire-department valve is marked strongly by simplicity, solidity and security. Drawings are herewith reproduced of the 14-inch vertical size and of the 16-inch horizontal valve.

*Chief engineer, Pelton Water Wheel Company.

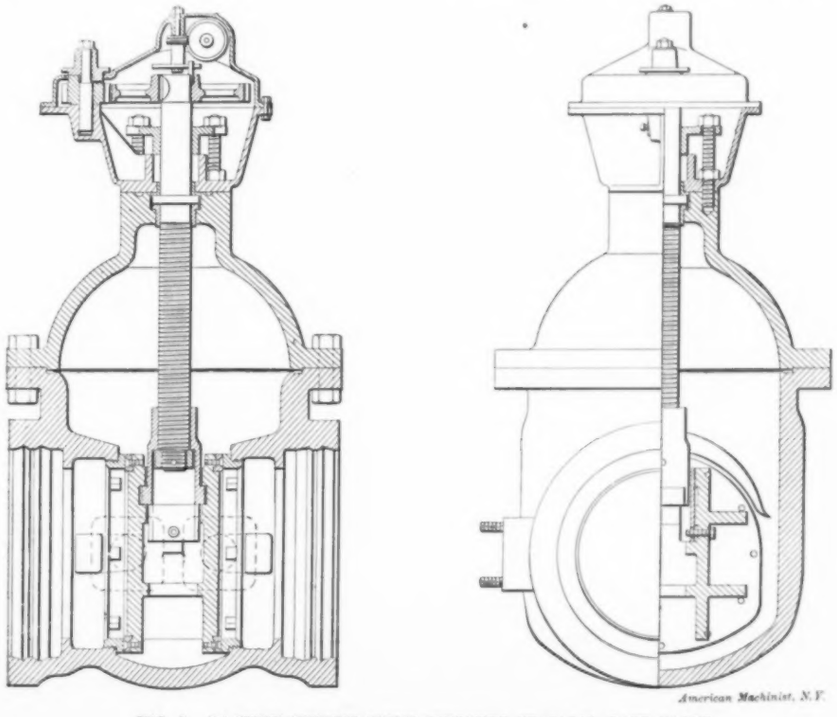



FIG. 1. 14-INCH PELTON HIGH-PRESSURE VERTICAL GATE VALVE

A non-shrinking alloy, according to *The Metal Industry*, is composed of the following: Tin, 50 lb.; zinc, 50 lb. This gives a tough, hard metal that runs well if a good grade of zinc is used. The addition of 2 pounds of bismuth will render it even more fluid and enable it to be poured at a lower temperature. By using heavy sprues and pouring cold the shrinkage, which is slight, may be to a very large extent overcome.

# Practical Letters from Our Readers

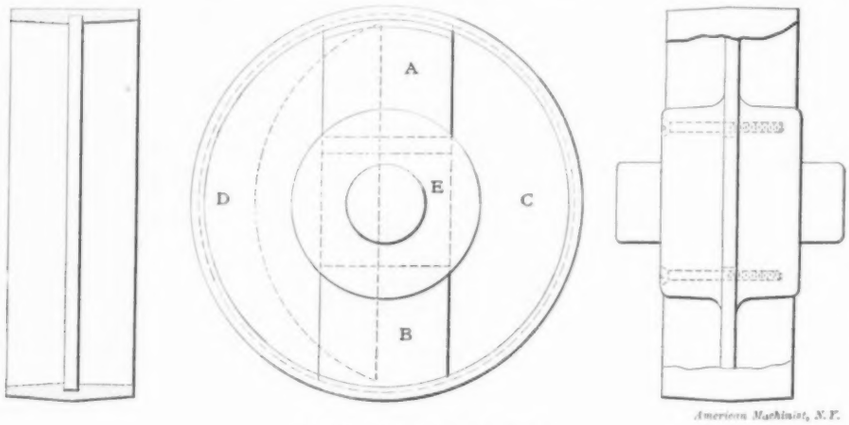
## A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

## WE PAY FOR USEFUL IDEAS

### Pattern for Plate Pulley

Having had the occasion to make several different sizes of small plate pulleys and not wishing to go to the expense of making a pattern with a rim of built-up wooden segments which is the usual practice, I devised the following method of making it:

The rim for the pattern was made out of a cast-iron ring, which was bored and turned with the necessary taper for drawing out of the mold, as shown to the left of the line cut. In the center of the inside of the ring a groove was cut out, the same width as the thickness of the pulley plate, and 3/16 or ¼ inch deep, as shown.




PATTERN FOR PLATE PULLEY

The patternmaker then made the plate of wood in four sections, as shown at *A B C D* in the central view. Section *D* of the plate was inserted in the groove first, then section *C*, and then *A* and *B*. The dotted lines show *A* and *D* in position ready to insert in the groove.

After inserting the four sections the space *E* can be filled up with a piece of the same thickness or the hub can be built on over the opening.

The two bosses, which form the hub, are loose pieces that are put on either side. The core prints are attached to these and they are fastened to the plate by two screws, as shown in the view to the right. To obtain the rounded corners between the plate and bosses, or plate and rim, leather fillets are fastened in position.

This reduces the cost of the pattern and at the same time makes one that will wear a long time. It also enables one to work nearer to finished sizes, and this means castings of less weight and with less time consumed in machining.

Manchester, Eng. A. HEARN.

### Some Combination Square Kinks

Consideration of the success attending the marketing of this combination square, in connection with its faulty design, leads one to the belief that the buyers were and are a very easily pleased lot of men. About the only reasonable explanation of its appearing in the kit of almost every metal-working mechanic is that it is cheap and in some ways convenient. Its convenience lies in its detachable adjustable blade. Its great fault lies in the 45-degree projection on the head.

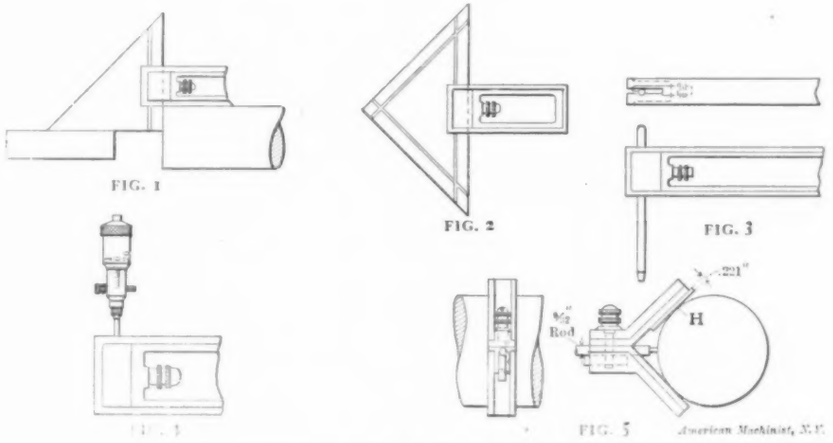
In questioning many machinists and toolmakers as to the uses found for this projection each and all, but one, have said without hesitation that no use had yet been found for it. The one exception is recognized as a crank among cranky cranks.

If this projection could be called useless only, it would be bad enough, but it is worse than useless, it is positively in the way. How much handier a head with parallel sides is. It is now possible to buy such heads of convenient sizes and provided with a groove along one side to facilitate setting the head on a shaft or other cylindrical surface. Why tool manufacturers were so slow getting such a tool before us is not easy to see; and still more difficult is it to see why so few are bought.

Such a parallel head made for me some years ago has been one of my most often used tools. It is 2 inches wide and 6 inches long, has a groove along one side, and no level. The lack of a level in the head has rarely been felt. The head was made this size to carry some extra long blades made to order, but it has never been too large for the standard 12-inch blade which fits it.

A blade of triangular shape, see Fig. 1, which I believe has been described in the AMERICAN MACHINIST, is occasionally met with in the kits of thoughtful workmen, and should be made and sold by tool manufacturers generally. It is shown here in use setting two shafts of different diameters in line. Those saturated with the utility of the 45-degree angles may have clamping grooves on all three sides of this triangle and be able to get the position shown in Fig. 2 which may be of use more often than the horn on the standard head.

Another adaptation of this universal tool that I have seen but once, and that should be worth a large part of a small fortune to the one who markets it, is shown in Fig. 3.




SOME COMBINATION SQUARE KINKS

The head is here shown in use as the head of a large-size depth gage. The needle is 5/32-inch cold-rolled steel or drill rod, and is easily clamped firmly enough for this use. Smaller rod might be used but 5/32-inch was chosen because it is the size of most small size inside micrometer rods. It will readily be seen what a fine hight gage this makes, as shown in sketch, Fig. 4.

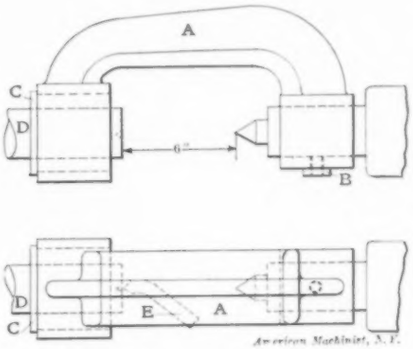
The center head that is a part of any complete "combination set" is often useful on rough work and can by very little work be made a great convenience in measuring between parallel shafts or from a shaft to other points, see Fig. 5.

The center head is here shown drilled for 5/32-inch rod very much as the parallel head is shown drilled in Figs. 3 and 4. The drilling of the center head is not so easy as drilling the parallel head for the 5/32-inch rod. To drill it so that the rod will be radial to a cylinder between the two wings of the head, would not only be difficult but be likely to spoil the head for use with the standard blade. Drilling it one-half the diameter of the rod off the center as shown makes no difference where parallelism of shafting is sought, and a liner of proper thickness can be used as shown when exact distances are required. The sketch shows a small parallel strip used between the hook of the clamping screw and the rod.

Morton Park, Ill. R. S. WILLIAM.

## Centering Small Stock in the Lathe

The accurate centering of stock in the average centering machine is an impossibility owing to the fact that the stock is held stationary. The steady rest produces a better job but is unhandy and slow owing to the necessity of opening and closing every time a new center is to be made.




CENTERING SMALL STOCK IN THE LATHE

The line cut shows a centering device I have made which has all the advantages of centering in the steady rest but is quick and handy.

*A* is a casting which is bored at one end to fit the tail spindle, to which it is clamped by the set screw *B*, the end of which is provided with a soft metal shoe, or mouse, to prevent the marring of the spindle. The other end of *A* is bored any suitable size for the bushings *C*; cold rolled is quite good for these bushings. If much work is done they can be case-hardened and ground and lapped or even made of tool steel; the operator must judge of this for himself.

The stock *D* is a snug running fit for the bushing *C*.

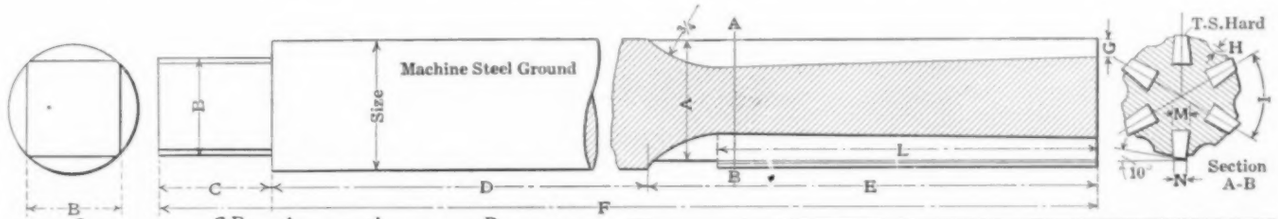
*E* is the regulation angular centering tool mounted in the slide rest.

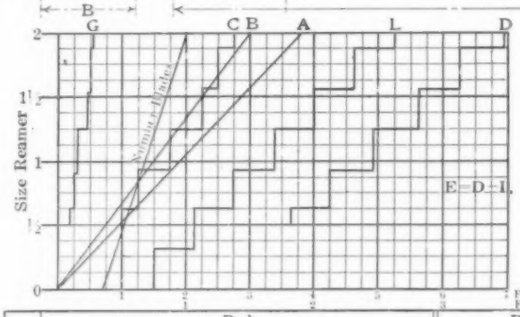
With properly fitting bushings stock can be centered quickly and very accurately with this attachment, which is easily made, takes up little room and is easily attached to and detached from the tail spindle. The stock is held and driven by the chuck.

Nashua, N. H. WM. HEBERT.

## Inserted Blade Reamer Dimensions

The accompanying drawing gives dimensions of standard adjustable blade reamers which I have constructed for the Walter Scott Press Company, of Plainfield, N. J. These reamers have proved very successful. The blades are made of Blue Chip steel. Perhaps some of the readers of the AMERICAN MACHINIST may find this




| Size | Body | | | | | | | | | | Blades | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stock | A | B | C | D | E | F | G | H | I | No. | Stock | L | M | N |
| 1/2 | 5/8 x 6 7/8 | 15/32 | 3/8 | 1/2 | 3 5/8 | 2 5/8 | 6 3/4 | 3/32 | 3/32 | 90° | 4 | 3/16 x 1/8 | 2 1/8 | 3/32 | 1/16 |
| 9/16 | " | 17/32 | 7/16 | " | " | " | " | " | " | " | " | " | " | " | " |
| 5/8 | 3/4 x 8 1/4 | 37/64 | 1/2 | 5/8 | 4 1/4 | 3 1/4 | 8 1/8 | 1/8 | " | " | " | 1/4 x 3/16 | 2 3/4 | 1/8 | 3/32 |
| 11/16 | " | 41/64 | 1/2 | " | " | " | " | " | " | " | " | " | " | " | " |
| 3/4 | 7/8 x 8 1/4 | 45/64 | 9/16 | " | " | " | " | " | " | 72 | 5 | " | " | " | " |
| 13/16 | " | 49/64 | 5/8 | " | " | " | " | " | " | " | " | " | " | " | " |
| 7/8 | 1 x 8 1/4 | 53/64 | 5/8 | " | " | " | " | " | " | " | " | " | " | " | " |
| 15/16 | 1 x 9 7/8 | 7/8 | 11/16 | 7/8 | 4 15/16 | 3 15/16 | 9 3/4 | 5/32 | " | " | " | 5/16 x 3/16 | 3 3/8 | 5/32 | 7/64 |
| 1 | 1 1/8 x 9 7/8 | 15/16 | 3/4 | " | " | " | " | " | 1/8 | 60 | 6 | " | " | " | " |
| 1 1/16 | " | 1 | 13/16 | " | " | " | " | " | 1/8 | " | " | " | " | " | " |

| Size | Body | | | | | | | | | | Blades | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stock | A | B | C | D | E | F | G | H | I | No. | Stock | L | M | N |
| 1 1/8 | 1 1/4 x 9 7/8 | 1 1/16 | 7/8 | 7/8 | 4 15/16 | 3 15/16 | 9 3/4 | 5/32 | 1/8 | 60 | 6 | 5/16 x 3/16 | 3 3/8 | 5/32 | 7/64 |
| 1 3/16 | " | 1 1/8 | 7/8 | " | " | " | " | " | " | " | " | " | " | " | " |
| 1 1/4 | 1 3/8 x 11 1/2 | 1 3/16 | 15/16 | 1 1/8 | 5 5/8 | 4 5/8 | 11 3/8 | 7/32 | " | " | " | 3/8 x 1/4 | 4 | 3/16 | 1/8 |
| 1 5/16 | " | 1 1/4 | 1 | " | " | " | " | " | " | " | " | " | " | " | " |
| 1 3/8 | 1 1/2 x 11 1/2 | 1 15/64 | 1 | " | " | " | " | " | " | 51 3/7 | 7 | " | " | " | " |
| 1 7/16 | " | 1 23/64 | 1 1/16 | " | " | " | " | " | " | " | " | " | " | " | " |
| 1 1/2 | 1 5/8 x 11 1/2 | 1 27/64 | 1 1/8 | " | " | " | " | " | 3/16 | " | " | " | " | " | " |
| 1 9/16 | 1 5/8 x 12 7/8 | 1 31/64 | 1 3/16 | 1 1/4 | 6 1/4 | 5 1/4 | 12 3/4 | 1/4 | " | " | " | 7/16 x 1/4 | 4 5/8 | 7/32 | 5/32 |
| 1 5/8 | 1 3/4 x 12 7/8 | 1 35/64 | 1 1/4 | " | " | " | " | " | " | " | " | " | " | " | " |
| 1 11/16 | " | 1 19/32 | 1 1/4 | " | " | " | " | " | " | " | " | " | " | " | " |
| 1 3/4 | 1 7/8 x 12 7/8 | 1 23/32 | 1 5/16 | " | " | " | " | " | " | 45 | 8 | " | " | " | " |
| 1 13/16 | " | 1 25/32 | 1 3/8 | " | " | " | " | " | " | " | " | " | " | " | " |
| 1 7/8 | 2 x 14 3/8 | 1 25/32 | 1 3/8 | 1 3/8 | 6 15/16 | 5 15/16 | 14 1/4 | 9/32 | " | " | " | 7/16 x 5/16 | 5 1/4 | 1/4 | 3/16 |
| 1 15/16 | " | 1 27/32 | 1 7/16 | " | " | " | " | " | " | " | " | " | " | " | " |
| 2 | 2 1/8 x 14 3/8 | 1 29/32 | 1 1/2 | " | " | " | " | " | " | " | " | " | " | " | " |

American Machinist, N. Y.

INSERTED-BLADE REAMER SIZES

table of value as it may save them much time and labor in making reamers.

JOSEPH R. WEANER.

Plainfield, N. J.

## Tempering Records

During the last year there have been many articles in the AMERICAN MACHINIST regarding the tempering of tool steel for different purposes. However, I have not noticed anything just like a method I put into use some time ago, which is bringing very good results.

The tools on which this method was used were principally press tools, such as perforating, blanking and forming dies. They were used for a wide range of materials, from very soft to 0.70 per cent. carbon steel and were from 0.020 to 0.50 inch in thickness. Some very delicate points to contend with were on some of the punches and dies.

The temper and steel that are just right for one tool would not do for another. Thus we found it very hard to judge at just what temper we would get the best results from a certain tool for its particular class of work.

In order to get a better line on this we used the following method:

I had tempering-record cards printed as shown. Before tempering (one man doing all the tempering) each tool is numbered with small stencils at some point where stamping will not affect the tool, and where the number will not be ground out. A corresponding number was put on the temper-record card.

The card explains how a full record of the steel used and the tempering of the tool are made out. These cards are filed in a case.

If after the tool is put into use, it shows the temper too hard or too soft for the work it has to do, we simply find the number on it and refer to the corresponding number in the card records. This tells us exactly what steel was used and what temper it was given.

In this way we are very fast getting a line on what steel and at what temper we can get the most service from each tool for its particular class of work.

From these record cards we are gradually making up a chart, with the names of our different tools arranged alphabetically; the kind of material the tool has to work upon, etc.

After we are satisfied with the results we are getting with a certain tool, the tempering record is copied in a short form on this chart. Then in making duplicate tools we refer to the chart, which tells us the kind of steel to use and the proper temper to give it.

Probably the scleroscope would be a good thing to use in connection with this method but we have not added it to our equipment, as yet.

Indianapolis, Ind. H. L. KOHR.

*TEMPERING RECORD*

*DATE* _____ *No.* _____

*TOOL* _____

*STEEL* _____

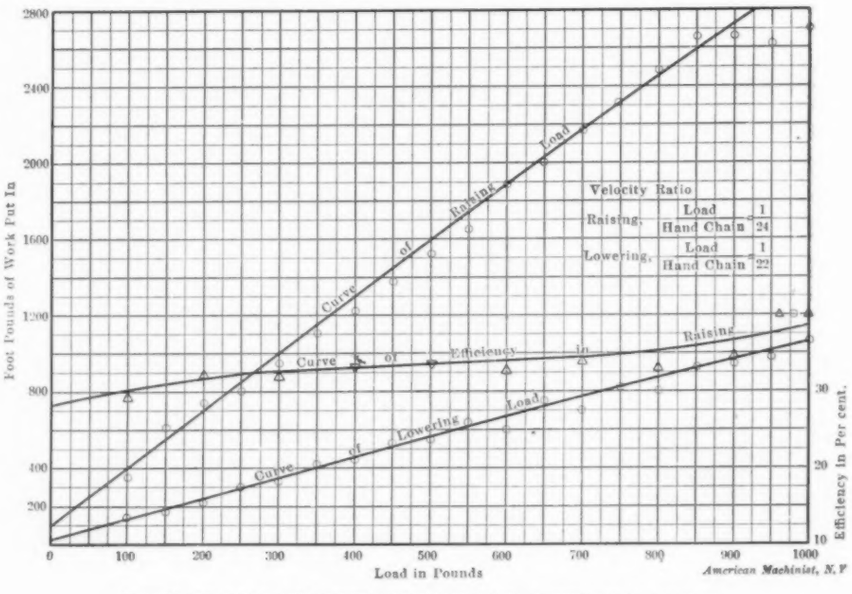
*HARDENING HEAT* _____ *BATH* _____

*TEMPERING HEAT* _____ *TEMPERING COLOR* _____

*REMARKS* _____

*FOR FURTHER INFORMATION SEE OTHER SIDE.* *American Machinist, N.Y.*

RECORD CARD FOR TEMPERING TOOLS


Foot Pounds of Work Put In
Load in Pounds
Efficiency in Per cent.
Curve of Raising Load
Curve of Efficiency in Raising
Curve of Lowering Load
Velocity Ratio
Raising: Load 1 / Hand Chain 24
Lowering: Load 1 / Hand Chain 22
American Machinist, N.Y.

CURVES OF LOAD AND EFFICIENCY OF 1000-POUND CHAIN HOIST

## Efficiency of a Duplex Chain Hoist

It is quite commonly believed that a duplex or triplex chain hoist is a very efficient piece of apparatus.

The results given in this article are the averages of 8 tests taken at different times. The hoist was brought on the market without any attempt to get a particularly good one or a bad one. It is rated at 1000 pounds capacity. The upper pulley has two chain grooves, one having 12 link pockets and the other 11. The ratio of distance through which the load is moved to the distance passed over by the hand chain is 1 to 24 while raising the load. When lowering the load the ratio is 1 to 22 when using the hand chain.

The chart shows the relation of the work done by the load (force × distance) and the work done by the hand chain in raising and lowering.

The efficiency is worked out for raising only and it is the ratio of work done to work put in. It is seen that the efficiency is 40 per cent. for the best condition. That is, there was 2½ times as much work done on the hand chain as there was in raising the load. This type of hoist is not to be condemned because of the condition. Much work can be accomplished. It is possible to lift heavy weights by a comparatively small force acting through a great distance even when the friction is considerable.

Lansing, Mich. J. A. POLSON.

The *Canal Record* shows that cost of repairs to steam shovels at the Empire shops of the Canal Zone during the fiscal year of 1909 was only ⅞ cent per cubic yard of material excavated, a total of $197,612.

# Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

## WE PAY FOR THESE ALSO

### Should Screw Threads Have a 60-degree Angle at Right Angles to the Helix?

The ingenious device for measuring screw threads described by Mr. Scribner at page 292 is the only instrument I have seen in my experience which claims to measure threads at an angle of 60 degrees, parallel with the axis of the thread, with the exception of rather an elaborate English device in which the gage or tap to be measured is held on centers and the measuring done with a pair of knife-edge templets or points actuated by a micrometer dial, as shown in Fig. 1.

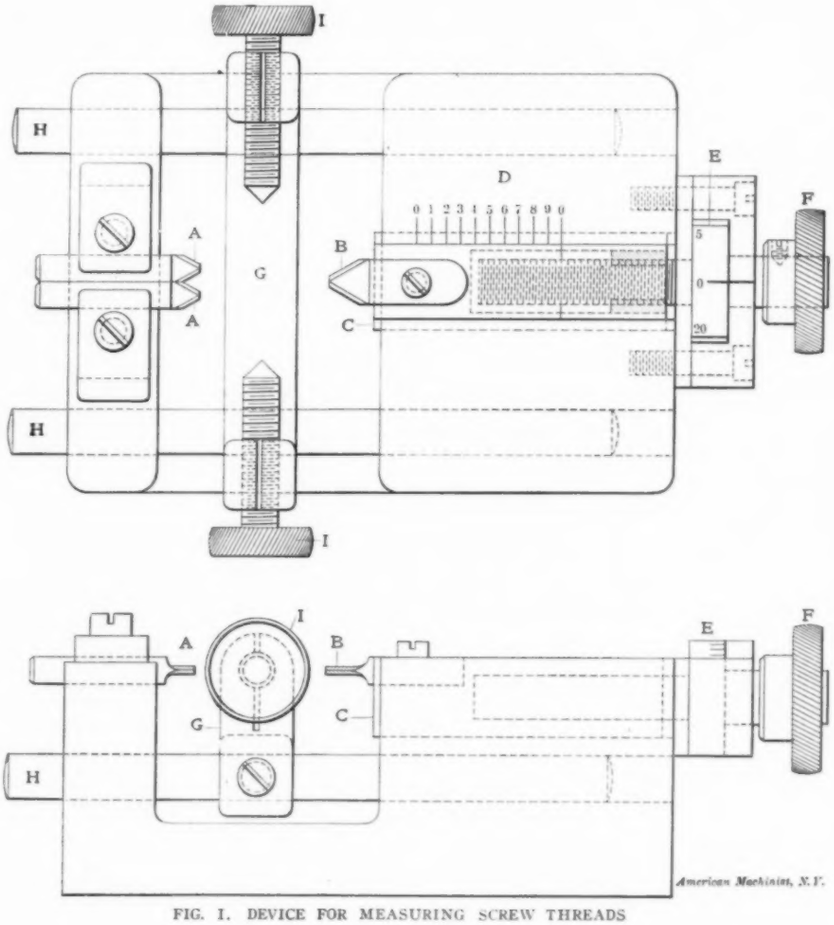



FIG. 1. DEVICE FOR MEASURING SCREW THREADS

I show this as it is in my opinion something of a curiosity, and illustrates what measuring threads parallel to the axis really means. Points *A* are removable for inserting the proper ones for different pitches; they are adjusted to point *B* when the dial is set to zero. Point *D* is carried in the slide which is actuated by the left-hand micrometer screw. Readings are taken in a similar manner to the ordinary micrometer from scale *D* and dial *E*. Thumb piece *F* is held on the screw spindle by a set screw. Frame *G* carries the center screws *I I*, which hold the gage to be measured. These screws are adjusted like lathe tailstock screws in order to bring the portion of the gage to be measured opposite the points. The gage itself is turned on the centers until the thread matches points *A*. *H H* are round rod carriers sliding in the main frame to which *G* is securely fastened.

After the gage is swung between centers and turned to its proper position, frame *G* is pushed up until the gage is in engagement with points *A*, and then point *B* is fed up and the reading taken.

It correctly meets the theory of measuring in the axis of the thread, but the impracticability of sufficient accuracy in manufacture and also of manipulation are apparent to any mechanic acquainted with this kind of work. As this instrument was jealously guarded by its owner as a mystery and only exhibited during the rare confidential moments of a rather conservative Englishman (who used to boast in a rather disparaging way that he never read the AMERICAN MACHINIST) I had no opportunity to definitely ascertain its value, but I have never been tempted to build one like it, although I would value it as a unique and ornamental paper weight, it being polished all over with that astrakan-wool curly-cue finish which they put on the inside of watches.

I do not wish to appear in a critical light in expressing my views, nor do I want to belittle the value of the interesting article at page 292, but I feel constrained to point out what I consider the weak points of the micrometer submitted.

The first trouble is the difficulty or impracticability of getting the lateral adjustments correct and in getting the adjusting mechanism at perfect right angles to the center line of the micrometer points. Nor are any means provided for checking its accuracy when the lower point is adjusted off center. Another objection to this type of instrument is that the parts in contact when measuring have only a line contact with each other, permitting rapid wear on the instrument, and flat places soon appear on the conical members causing errors, particularly serious on the revolving point.

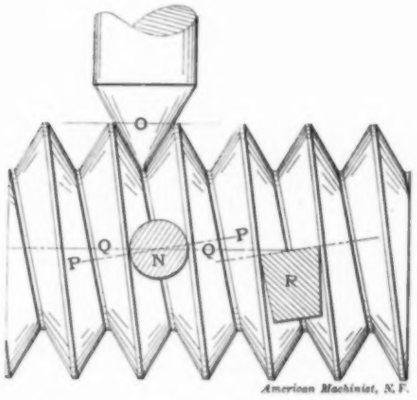



FIG. 2. MEASURING SCREW THREADS

We all know that a more sensitive "feel" is required with a Brown & Sharpe thread micrometer in measuring threads than with an ordinary micrometer on plain cylindrical work. Well, in a micrometer constructed on the principle shown, i.e., with two offset male centers, which I had made as an experiment some years ago,

the "feel" was still less sensitive, and after a few weeks' trial was condemned in our gage room for this reason chiefly, and we fell back on the Brown & Sharpe system. The argument advanced was that because the centers were offset and not opposite it was practically impossible to hold the thread to be measured with its axis in the same plane as the offset of the centers, that either one point or the other would pass the high spot first. Among the 12 men in our gage room, a difference in their measurements with this instrument was found on the same screw of approximately 0.0018 inch, while with a Brown & Sharpe micrometer the difference amounted to only 0.0003 inch. A screw gage given at different times to the same gage maker to measure with this instrument showed also that the same individual could not repeat previous measurements with the same degree of accuracy as by other means.

While this was a homemade tool and not identical with the one described by Mr. Scribner, the workmanship was first-class, and careful examination showed practically nothing in its construction which would cause the trouble and we finally decided that the principle involved was at fault.

It also seems to me that a sidewise stress on the screw thread, by the sides of the offset points which are adjacent to one another, tends to tilt the thread, or, in other words, to cramp and swing the axis of the thread out of a 90-degree position with the micrometer spindle. The slightest fraction of error in the 60-degree angle of the thread would intensify this, as would any inaccuracies of lead and there is no question as to the difficulties in producing perfect lead in screws and hardened gages and taps.

Does a conical 60-degree point as shown in the sketch given by Mr. Scribner, when used in measuring a screw thread, actually measure the portions of the thread sides which would be parallel to the axis or not? Referring to the sketch, Fig. 2, it appears that the circle $N$, representing a top view of the section of the conical point at $O$, would touch at or near the sides of the thread where cut by a line perpendicular to the helix angle at $P\,P$ instead of at $Q\,Q$, as the curvature from $Q$ to $P$ in the circumference of the thread is so slight in such a short distance as hardly to give clearance enough to permit contact at $Q\,Q$.

I would like to ask Mr. Scribner if his instrument is not really better adapted to measure threads cut with 60-degree thread tools with the top face tilted perpendicular to the lead angle as in Fig. 2 at $R$, which would insure a line contact at points $P\,P$, Fig. 2. If some ardent and accurate geometrican would plot or figure this out it would be of interest to many who have to do with measuring screw threads.

We are now using male and female blocks in an ordinary micrometer which adjust themselves to the helix angle, as shown in the sketch, Fig. 3, and find them durable and sensitive, and obtain uniform results with them.

The contact pieces themselves in our thread micrometer are made from pieces of steel machined, ground and lapped to a perfect triangular section, ascertained by measuring across the corners and also from each corner to the opposite flat surface. One piece is sweated into a holding block at $L$ for the spindle end and two pieces (with one corner ground off perpendicular to one side of the triangle) are sweated into another holder for the anvil at $K$. The holder for $K$ is loosely retained by a nut and is loose enough laterally to permit of adjusting itself to proper alinement when in use. The holder for $L$ will revolve freely in the spindle, suction preventing its dropping out. $M$ is an auxiliary spring sleeve graduated and slipped over the barrel to enable the tool to be set correctly to zero. This also makes up for the space required by the

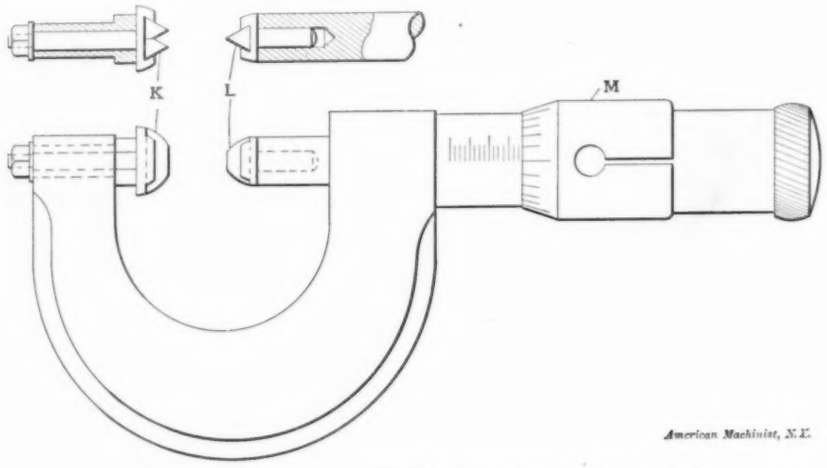



FIG. 3. MICROMETER ARRANGED FOR MEASURING SCREW THREADS

V-blocks as well as providing a very handy means of adjustment. Both V-blocks, being free to turn, adjust themselves readily to the helix angle on both sides of the thread to be measured. The inception of the idea was in the repairing and improving of some thread micrometers which were badly worn in spots on the conical point, and as, after a trial of several months, popular opinion in our gage room was in favor of the micrometers thus repaired, we adopted this design for our regular tools and changed over all the old and new micrometers that we had. We now use micrometers of the regular type with the ten-thousandths vernier, converted as shown, because we can get a more accurate job in the converting process, and they also permit finer readings to be taken. Other firms who have employed men which have left us have indorsed the method by adopting it.

In regard to the feasibility of making threads 60 degrees across the lead angle, a system which allows them to be accurately measured in the lead or helix angle by the ordinary methods, ball points, wires, Brown & Sharpe micrometers, V-block points, etc., I can see no objection to using a swiveling tool, or a tool ground on top perpendicular to the helix or lead angle. I use both these methods, having in addition to swiveling tool holders, thread tools ground on top and sides to suit three different angles and stamped with the angle for identification.

One is ground to suit the mean lead angle of the various screws on the list and the other two approximate the extremes, and I find by this method that differences such as found by Mr. Dudley and referred to at page 1045, Part 1, are unperceptible.

I would strongly urge cutting threads with a uniform 60-degree angle between the two sides of the thread helix and perpendicular to the helix angle of the pitch diameter, regardless of lead angle, diameter, or shape of thread across the axis, as it eliminates much uncertainty in measuring and permits the use of the different forms of measuring contacts now in vogue, with the exception of the English instrument described, which is not so *very much* in vogue.

Brooklyn, N. Y. R. K. MELVIN.

## Convenient Size Blocks

It seems to me that H. E. Curtis, in his pile of convenient size blocks, shown at page 500, has made several more than he needs to get every sixty-fourth up. One each, 1/64, 1/32, 1/16, ⅛, ¼, ½ and one inch, will give every sixty-fourth, to 1 63/64, and with one more 1/64 each can be compared with a pile of all below it, making that extra 1/64 piece a very valuable addition, and this will make an even two inches, and two piles of 1 inch, ½, ¼, ⅛ and 1/16 inch.

Rochester, N. Y. A. L. ROOT.

# Machine Tool Builders' Convention

## The Standardization of Electric Motors and the Training of Mechanics Occupy Leading Places on the Program. Stereopticon Lectures a Feature

## EDITORIAL CORRESPONDENCE

The annual convention of the National Machine Tool Builders' Association convened at the Hotel Astor of this city, October 12 at 10 a.m., with President Eberhardt in the chair. The proceedings were opened with the usual formal roll-call, reading of minutes, enrolling new members, and report of the president. This report referred to the growing influence and importance of the association, and its benefits to the trade as a whole, and its members as individuals. The important and far sighted action of the association in advocating a reduction of the tariff on the goods manufactured by its members was referred to, although in a much more moderate spirit than would have been justified.

The action of the association in having the work of Captain Carden in Europe continued, was likewise referred to, as was the importance of the educational mission of the association, especially in connection with the determination of true costs of production.

The report closed with the recommendation that the various committees consider and adopt maximum dimensions for the essential parts of machines of a given size.

The preliminary report of the committee on standardizing electric motors as applied to machine tools was then presented.

It appears that the motor manufacturers are contemplating the production of a new class of motors to be known as machine-tool motors, and a conference has been held between the committee and the Motor Manufacturers' Association.

The points on which it is aimed to bring about uniformity are base and bolt-hole dimensions and locations, tolerances, shaft diameters, maximum speed of motors and peripheral speed of gears, the question of speed being the one which has given the most trouble. The report contains a preliminary table of maximum and minimum speeds of variable-speed motors having a range from 1½ to 1 up to 4 to 1. The table is presented herewith.

The report brought out a very animated discussion, the general nature of which was an expression of dissatisfaction, the chief point criticized being the upper speed limits which, in the opinion of many, were much too high for connection by gears.

The situation when the subject was under discussion by a previous committee, was pointedly referred to, this situation being a general desire on the part of motor manufacturers that the machines be standardized but with the feeling in each case that the construction of each manufacturer was the proper standard for all to adopt. At present this condition exists in a much less degree if it exists at all, motor manufacturers through their association having become convinced of the advantages of standardization and now desire to bring it about by cöoperation.

The report was finally referred back to the committee without specific recommendation, although the points raised in the discussion can scarcely fail to be taken into consideration and be reflected in the final report. It may be fairly stated that the outlook for standardizing the essential features of motors for machine tools, with the consequent avoidance of annoyance and unnecessary expense is at least reasonably bright, and in view of the burden which this annoyance and expense has been to machine-tool makers in the past, this outcome, should it follow, will alone go far to justify the existence of the association.

| H.P. | Maximum Speed. | Range. | | | |
|---|---|---|---|---|---|
| | | 4 to 1 | 3 to 1 | 2 to 1 | 1½ to 1 |
| 1 | 2200 | 550 | 740 | 1100 | 1480 |
| 2 | 2200 | 550 | 740 | 1100 | 1480 |
| 1 | 1800 | 450 | 600 | 900 | 1200 |
| 2 | 1800 | 450 | 600 | 900 | 1200 |
| 3 | 1800 | 450 | 600 | 900 | 1200 |
| 5 | 1800 | 450 | 600 | 900 | 1200 |
| 7½ | 1800 | 450 | 600 | 900 | 1200 |
| 10 | 1800 | 450 | 600 | 900 | 1200 |
| 2 | 1500 | 375 | 500 | 750 | 1000 |
| 3 | 1500 | 375 | 500 | 750 | 1000 |
| 5 | 1500 | 375 | 500 | 750 | 1000 |
| 7½ | 1500 | 375 | 500 | 750 | 1000 |
| 10 | 1500 | 375 | 500 | 750 | 1000 |
| 15 | 1500 | 375 | 500 | 750 | 1000 |
| 15 | 1200 | 300 | 400 | 600 | 800 |
| 20 | 1200 | 300 | 400 | 600 | 800 |
| 25 | 1200 | 300 | 400 | 600 | 800 |
| 30 | 1200 | 300 | 400 | 600 | 800 |
| 20 | 900 | 225 | 300 | 450 | 600 |
| 25 | 900 | 225 | 300 | 450 | 600 |
| 30 | 900 | 225 | 300 | 450 | 600 |
| 40 | 900 | 225 | 300 | 450 | 600 |
| 30 | 720 | 180 | 240 | 360 | 480 |
| 40 | 720 | 180 | 240 | 360 | 480 |
| 50 | 720 | 180 | 240 | 360 | 480 |

PROPOSED STANDARD SPEEDS OF VARIABLE SPEED MOTORS.

Following a discussion of this report, the convention was addressed by Max Vieweger, manager of the American Exposition to be held in Berlin, in May, June and July of next year. Mr. Vieweger began his address by reading a letter from the Department of Commerce and Labor, which virtually indorsed the proposed exposition, and he then followed with a brief account of its plan and purpose. It is to be the first all-American exposition to be held on foreign soil. The financial risk is to be assumed by the owners of the building in which the exposition is to be held, in combination with the business men of the city of Berlin. To enable intending exhibitors to forecast the probable cost of exhibits, it has been arranged that the charge for space, which has been placed at $4 per square foot, shall cover the usual uncertain incidentals which commonly attend the installation and operation of exhibits.

The whole matter was referred to the standing Committee on Exhibitions.

The next item in the order of business was the reading of a communication from the National Supply and Machinery Builders' Association, presenting the claims of the members of the association for an increase in the commissions allowed for the sale of machine tools, and following the reading of this communication several members of a committee of the association presented these claims more fully, substantiating them by the reading of figures regarding the cost of conducting business and making sales.

To the expression of a desire for a uniform rate of commission the committee was asked if they considered the cost of selling to be the same on large and small sales, and if the commissions should be uniform on all sales. To this it was replied that the actual cost of making individual sales is impossible of determination, as it is made up partly of direct expense undertaken with a view to the sale in view, and partly of general expenses which cannot be classified among individual sales.

The report was referred to the various committees with the request that it be carefully considered.

Following this came an address by E. P. Bullard, Jr., on the "Creation of Machinists." Mr. Bullard referred to the action already taken by the association in organizing full and partial systems of apprenticeship, and stated that while the full apprenticeship plan would always be needed for the training of all-around mechanics from whom leading men must be selected, the crying need of the time is for a method by which satisfactory operatives can be quickly trained, and this he claims has been fully met at the works of the Bullard Machine Tool Company by the partial apprenticeship system, in which men of more mature age than has been customary are trained for the operation of individual machines, such as lathes, planers, boring mills, milling machines, etc.

It has been found feasible to give men this limited degree of training, making them very satisfactory workmen in about a year's time, and to pay them a rate of wages which attracts them to the shop, and supports them during their apprenticeship.

Another member referred to his own experiences on somewhat similar although still more restricted lines. He had found advertising for apprentices in the ordinary sense of that term to be of very little avail, while attempts to secure recruits from the public schools had been no more successful, although the wages at the start had been raised from 5 to 8 and eventually 9 cents per hour.

The next procedure had been to rearrange the work of the shop in such manner as to simplify individual operations as far as possible, and then to advertise for men of from 20 to 30 years of age. The first advertisement resulted in the immediate appearance of a number of applicants from whom 12 were selected, and distributed one to each of the 12 departments of the works, with instructions to the foreman to give them individual instruction in the actual doing of a single operation. It was found that these 12 men were readily assimilated, and at the end of the first month the shop was ready for another similar instalment. A first-class machinist was engaged as shop instructor to go among these men and deliberately teach them the work to be done. The installation of some new tools had been necessary and the result at the start was a reduced production, but as the new men became better acquainted with the work they were advanced from 15 to 17½ cents, and in some cases to 20 cents per hour. The spoiled work increased in amount but the final result—a sufficient number of men to run the establishment—was brought about.

The speaker considered that every employer of machinists should also be a producer of them, and that every machine shop should employ more beginners than it needs, as some upon graduation will drop out, others will be dropped, and others will go into new enterprises, which must have machinists ready made.

An essential feature of the plan is to place before the men permanently and in printed form certain instructions regarding the requirements of the work, instead of, as usual, depending upon the instructor to give this information orally to each individual, and samples of these instruction sheets were exhibited.

The afternoon of Tuesday was devoted to the meetings of the various committees, no session of the association as a whole being held.

### Wednesday, Oct. 13

The opening papers dealt with Industrial Education, in its relation to increasing the supply and efficiency of machinists, the first by F. A. Geier, who told of the Cincinnati, O., plan which was followed by M. A. Cooledge with a description of the method being followed in Fitchburg, Mass., both of which we publish below.

### The Cincinnati Plan

The rapid development of the manufacturing interests of our country during the past decade, and particularly in the metal-working lines, is yearly increasing the problem of finding an adequate supply of labor, and of a proper degree of efficiency.

The system of education in this country has not, until the recent past, taken cognizance of the change in the requirements of labor that has come about through this industrial development. Manufacturers have for some time realized that the efficiency of the labor that offers itself for employment, is not as high as it should be. To a large extent, this is due to the fact that the great majority of applicants have not gone beyond the elementary schools, and in which they were not prepared for meeting the problems that confronted them upon entering the manufacturing establishments. The courses of these elementary schools have not been such as to hold the interest of the boys, a great many leaving the schools at entirely too early an age, and with a very poor foundation even in the rudiments of education.

Manufacturing processes are becoming more highly organized and while there is a greater subdivision of labor, I believe it is true that we need a working force today of greater general intelligence than in the days when simpler machines and simpler processes were employed in producing our work. A careful analysis of the conditions in any manufacturing plant will reveal a tremendous waste, because of the abuse of machinery and tools, a low standard of work, spoiled pieces, etc., a great part of which waste could be eliminated if there were a higher degree of intelligence on the part of the workmen.

America has led the world industrially, because of the natural advantages of a large home market, and of its superior advantages as to cost of raw materials. Europe and notably Germany, largely offset our natural advantages, by a superior training of employees. Our advantages as to sources of raw materials, are lessening year by year. If we are to increase our home and foreign trade we must better train our employees. The movement to this end has begun, and I am asked to speak to you more specifically as to what has been done in Cincinnati.

Cincinnati has the oldest mechanics' institute in this country. This institution with its night classes, has been doing pioneer work along these lines for many years. It is, however, not a natural condition for young men to be compelled to get their education in this way. Boys attending these schools, tired out from the day's work, cannot make the progress that they should, and often become discouraged.

About four years ago, the board of education of Cincinnati established manual training in the elementary grades. Two magnificent technological high schools are about completed, and in these schools such training will be given as will be exceedingly useful to the boys as they subsequently enter manufacturing establishments. The courses comprise woodworking, metal working, foundry work, mechanical drawing, and such allied branches as physics, chemistry, etc.

You all know about the cooperative course for engineering established three years ago at the University of Cincinnati, in which boys who have passed through the high schools can enter this six-year course, working one week at the shop, and one week at the university, earning, during the period of six years, about $1800. About 200 of these boys are now employed in Cincinnati shops. While there are exceptions to the rule, these boys have as a class surprised their employers as to the character and quality of work they are able to do. In fact, the experience has been very satisfactory. Right in the beginning there was considerable skepticism on the part of manufacturers and a reluctance to accept these boys. The shops today are offering to take on more new men than the university facilities at present can take care of.

In our own plant we have found some of these boys available for some of our most difficult work and this is also true in other shops. I call attention to this because the experience with these engineering students has practically demonstrated to the Cincinnati manufacturers the value of educated and properly trained young men. The great mass of our employees, however, in the future, as in the past, will be supplied from those who only complete the elementary courses.

About three years ago, the firm of Houston, Stanwood & Gamble established a school in their own shop, giving instructions to their apprentices during shop hours. Their experience was so profitable that about a year later the Cincinnati Milling Machine Company established a similar school. We first attempted to operate this school at night, but because of the difficulty in insuring an attendance on the part of the boys, we soon decided to also operate this school during working hours. These two schools were noticed by other manufacturers, and were also brought to the attention of the board of education. After a number of conferences between the manufacturers and the members of the board of education it was decided, beginning with September, to operate a continuation school under the auspices and at the expense of the board of education. It was agreed by the manufacturers that they would send their apprentice boys and other young men to this school four hours per week, paying regular wages while the boys were in attendance. Over 200 boys are now enrolled, and as fast as additional teachers can be provided there is no doubt that this enrollment will be very greatly enlarged. You must remember that at present the boys that attend the

continuation school are all employed in machine shops. The course has not yet been brought to embrace the other industries in Cincinnati. The classes of this continuation school are limited to about 20 boys. They are taught elementary and higher mathematics, including problems in geometry and trigonometry. The whole plan of the school is to teach directly the problems that the boy encounters in the shop. The catalogs and blueprints of the machine manufacturers of Cincinnati are the text books, and through the cöoperation of the superintendents and engineers employed in the shops of Cincinnati, the work done at this school today is probably more practical and more effective than that of any other school in this country or in Europe.

The efficiency of these boys in the shop is already showing substantial improvement, and will increase as the teaching force and courses at this continuation school are amplified.

So much for the efficiency. Now as to the increase in the supply of labor. It was formerly exceedingly difficult to secure a sufficient number of candidates for apprenticeships. You can readily see that parents whose attention is now called to this new plan, appreciate at once that here is an opportunity for their sons to learn a trade, and at the same time to supplement their education. It also appeals to the boy. He wants to go to work, and while heretofore he has been indifferent to his studies at school, he now finds instruction that is alive with interest. The supply, therefore, of young men to learn the trade, is more than sufficient. So much already has been accomplished, that I look forward to the future with much hopefulness, and I sincerely trust that other communities will rapidly imitate Cincinnati.

Let me repeat, that the big problem before manufacturers of this country is to secure a larger and more efficient supply of labor. Industrial education is the remedy.

### Practical Methods of Instruction

William Lodge gave a little additional information in regard to the practical methods of instruction being used by the Cincinnati schools. The study is made interesting by taking actual examples, such as a drilling machine, and having a large drawing of one so all can see it. Then each student has a catalog of the maker of this drill, and turns to it while the instruction shows how to find the speed of each shaft and of the drill. Catalogs of machine tools are used very freely as reading lessons and in any way that can familiarize the boys with the different tools in an interesting way. The instructor visits the boys at their work in the various shops and finds just what problems confront them every day. This enables him to select examples and subjects for instruction, which vitally interest the boys and hold their attention as they see the reason for the problems given.

This has had the effect of attracting all the boys they can handle which is in marked contrast to the condition before this system was inaugurated, as it was then difficult to secure enough applications from desirable boys. The boys and their parents feel that the present plan gives them an opportunity to learn and that the prospects for the future are brighter than before.

### The Fitchburg Method

The Fitchburg plan of coöperative education, or coöperative industrial education as applied to mechanics, is an arrangement between the high school and the manufacturers of metal machinery, saws, engines, pumps and condensers, and other metal products, for a four years' course of apprenticeship, the first year all school work, the next three years school and shop work, one week in school and one week in the shop. The boys work in pairs —a shop taking eight apprentices has four working at all times. The boy going to work next week goes to the shops on Saturday before closing time for an hour or half hour, according to the nature of the work, and watches the job his alternate is on, and is then prepared to take up on Monday morning the operations he has previously made himself familiar with, or with such additional information or instruction as he feels he may need from his foreman.

When the shops are able to take a sufficient number of operatives under this system, the course can be very much improved, we believe, by a special instructor in each shop whose only duty will be to attend to his boys, giving them all the time and attention necessary. We expect to carry out this feature shortly.

The Fitchburg plan differs from the trade-school idea where any student may enter and go wholly through a three years' course without regard to his mechanical ability or fitness for much work, whereas we drop out the dead wood and try to bring out every boy a good, high-grade mechanic. In one trade school they wanted some plumbing done in the school itself, and, though they taught plumbing in this very school, they had to send out and get a plumber to do the work. With the exception of the Williamson school in Philadelphia it is, as far as I have heard, the only one where the shop part is made at all prominent.

Manual-training schools have also failed in their effort to do practical work along the line of the Fitchburg plan, primarily, I believe, for two reasons: They have failed to put the shop part on an equality with the academic and were not able to work under real commercial conditions. Under the Fitchburg plan the boys are paid for their time in the shops 10 cents per hour first year, 11 cents second year and 12½ cents the third year. The young man taking this course has just the same standing in the high school on the football team, athletics, lectures, and all advantages as the other students and puts it all over the other boys by always having some real money to do as he wishes with, and enjoying that feeling of independence human in us all.

The apprenticeship or school year commences July 1, and for two months it is a trial period exactly the same as in our former apprenticeship systems. If the boy does not care to continue he may stop, and if the manufacturer feels that he will not make good as a mechanic he is told so. If he continues he is under the same apprenticeship bond to go through the three years' course as formerly. We believe this form of bond or obligation is just as valuable as formerly, and it is kept in mind by the apprentice that he has entered into a business agreement, approved and guaranteed by his parents.

An outline of the studies, detailed as follows, shows how interesting and instructive the school work may be made:

*English*—Throughout the four years' course in order that he may speak and write intelligently, forms of business papers, shop terms and spelling.

*Mathematics*—Simple tables, lengths, areas, volumes, metric system, circular measure. General shop mathematics dealing with problems on cutting speeds and feeds, gearing, belting, strength of material. Algebra to facilitate in working out shop formulas.

*Mechanism*—Parts and construction of different shop tools, gearing, cutting threads, forms and action of cutting tools.

*Free-hand Drawing*—For quick shop sketching.

*Mechanical Drawing*—To help in reading blueprints and make up shop drawings if necessary.

*Industrial History*—History of iron industry, factory system and labor problems, new inventions, reading mechanical journals to keep in touch with progress in mechanical affairs.

*Physics and Chemistry*—As applied to everyday-shop practice, simple and common methods of testing iron and steel, hardening and tempering.

*Commercial Geography*—Centers of machine manufacture, source and cost of materials, labor conditions, railway systems, waterways and cost of transportation.

William B. Hunter, a technology man, with ten years' practical shop experience, is the special instructor in charge of this work, and the subjects taught in the course as just outlined are from special textbooks following the shop work very closely, cutting out the old academic studies entirely. Joseph G. Edgerly, for thirty-five years superintendent of the Fitchburg schools, has done everything possible to make this coöperative plan a success, and it has proved

up to date that this idea as outlined is the best course along coöperative lines.

The city authorities, high-school committee, high-school principal, teachers, citizens, and various organizations, have done all possible to make it such a success that the apprentices, their parents, and the manufacturers seem pretty well satisfied that here is a line of study and work on an actual commercial educational basis.

The scheme is adopted and worked out to fit our conditions along University of Cincinnati lines, as conducted by Prof. Herman Schneider to whom we owe a great courtesy for the attention he has shown us.

### Safety Appliances in Shops and Factories

Dr. W. H. Tolman gave a very interesting talk on the use of safety appliances in shops and factories. He showed the annual losses to the workers and to the country, for incapacitated workmen must be supported by someone, through preventable accidents, to be $125,000,000 a year. These are startling figures, but seem to be borne out by his statistics. The subject is particularly important at this time when there is a shortage of skilled men, as the injury to a good man reduces the output of the shop, and is expensive in several ways, aside from the suffering and loss he must bear. When these occur through easily preventable accidents, as is too often the case, they are all the more regrettable from every point of view.

### Reinforced Concrete for Shop Construction

In the afternoon J. P. H. Perry gave an instructive illustrated talk on reinforced-concrete buildings for shops, showing methods of construction, details of interiors and giving time and approximate cost of erection as compared with structural steel and mill construction of brick and wood.

### New Officers

The new officers are: President, F. A. Geier; vice-presidents, first, F. Eberhardt, second, P. E. Montanus; secretary, C. E. Hildreth; treasurer, G. W. Fifield.

The National Automatic Tool Company, Dayton, O., was admitted to membership in the association.

The spring meeting takes place in Rochester, N. Y.

The annual outing of *Machinery* across the harbor and lower bay to the Sandy Hook proving grounds. Thursday afternoon was the most successful and enjoyable of these events that has been provided by our enterprising contemporary. The machine-tool builders have come to look forward to these excursions with anticipations that are never disappointed.

## Follow-up Letters—Cost Systems—Buying Tools from Dealers

By Entropy

The man who invented follow-up letters did a great stroke for himself, but I am beginning to wonder if he ought not to have been indicted long ago as a common nuisance. If you write to a machinery house for prices on a 16-inch lathe, you get your prices promptly. Perhaps you decide you will buy an automobile instead so you drop the lathe proposition and inquire about automobiles. You drop the lathe matter but the lathe builder does not.

No, sir! He has a young woman in the office that used to work for a collection agency and you become her direct charge for the next five or ten years. She has a lot of form letters, some of which might have some connection with your case if you wanted a lathe, but more of which would be just as applicable to a prospect who had inquired the price of aëroplanes by the dozen. She has a card index of these letters which she shuffles and then sends them off in whatever order they come after the office boy cuts the pack. After a time you get calloused and then you get careless and they could send you hundred-dollar checks in their letters without your ever finding them. I had one case of this kind where the other fellow forgot himself and sent us an inquiry instead of a follow-up letter. About a month later one of his traveling men dropped in and wanted to know why they couldn't get our quotation.

I have one firm that I deal with both ways. They have a great system. Follow-up letters are sent out in the ordinary sized envelops with the address typewritten. Inquiries and orders come in the same sized envelops with the address strictly hand made. Checks come in large envelops with typewritten address. Once they sent a check in the ordinary size envelop. There must be something hypnotic about a check, for after I had thrown the letter in the waste basket I hunted it up again and opened it just for curiosity.

The follow-up letter and the form letter are both excellent things, but both have been abused until neither is of the value to the sender that it might be. The better thing in every case I believe to be a personal letter. One man cannot spread his efforts over nearly so many patrons if he takes personal care of each, but he may easily keep more customers if each one realizes that his orders are handled by a human being, rather than automaton. The form letter that cannot be distinguished from a personal letter has not yet been written, not even in as good shape as Mark Twain's celebrated speech for any occasion.

### Finding and Adapting a Cost System

We are bothered now to fit a cost-keeping system to our work. We can find plenty of fine systems to which we might fit our work, but we do not quite see our way to deliberately lose money for the sake of finding out what it costs.

Now our No. 16 Universal Clam Digger we build in dozen lots, that is, we begin a dozen as soon as the last dozen are sold. We begin in full faith that we will build the dozen right through, but about two weeks after we begin we get an order for one with a bonus if we get it out in 60 days. Some of the small parts it pays to make in lots so we put all hands on those parts and finish them up and lay them away. The beds we can just string on the big planer four at a time so we get in four and plane them up. All the parts of the jaws are made in dozen lots; but it is quite a job to set one up so we just set up one, and so it goes over the whole machine. When we get one done we want to know whether we made any money or not. It may be two years before we get the whole lot done and sold, and when they are all done there are a few No. 2 or No. 3 jaws left over owing to our bad luck in guessing what our customers would want. Somebody please suggest a scheme to fit our case?

### Buying through Dealers

Just now I am up in arms about agents and manufacturers who wish to protect their agents. Some advertise that they have certain agents in this region. Others say nothing about it but refer us to certain dealers and ask us to take it up with them. In other cases we hear nothing from the manufacturer but a few weeks later a genial traveling man from the dealer's house drops in and tells us he hears that we want to buy a gear cutter. If we are able to take him out in the shop and show him the machine we did buy, I feel well paid for the bother.

The most exasperating case is where we get a letter from the manufacturer saying that so-and-so, naming some well known dealer, will quote us on our requirements. A few days later so-and-so write asking us what it is we want prices on, and a week or two is lost because so-and-so will not quote on but one size machine at a time. The large dealers must lose a lot of business that they might get from us little fellows by this policy, for most of us are too bashful or rather too lacking in nerve to persist in writing for prices until we get what we really want and can afford. All these big manufacturers sell some machinery at low prices, as compared with other makes.

Why cannot all manufacturers agree on prices that they will ask and insist on their agents asking the same? Then they can quote on receipt of inquiry and the dealer will follow up the order. It saves time, worry and ill-feeling and nobody is worse off unless the dealer plans to charge an unreasonable profit.

# AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During* 1908 *we printed and circulated* 1,205,750 *copies of the* AMERICAN MACHINIST.

*Our circulation for September,* 1909, *was (weekly, monthly and European)* 111,750.

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|---|---|
| *October* 7 | 36,250 |
| *October* 14 | 19,000 |
| *October* 21 | 19,000 |

*This paper reaches* 36,250 *separate readers each month and* 19,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*


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## Know Where Your Valves and Pipes Are

Let us sketch a few familiar shop scenes. Some fine morning a belt runs off its pulley on the main line into the narrow space between that pulley and the one adjacent, promptly winds up and, mainly because it is a new belt, pulls down the countershaft that it should drive. In the resulting crash a live steam pipe connected with a soda kettle is snapped off short. Hot water and steam are sprayed over everything within a radius of 25 feet. The foreman starts off on a wild hunt for a place to shut off the pipe. Meanwhile splices of belts are being soaked apart, several workmen have been wet and scalded, and all of the bright parts of the adjacent machine tools and work are getting into a fine condition to rust. The commotion attracts the superintendent, and after he appreciates the situation he follows the foreman in trying to find a place to shut off the steam and water. After ten minutes or so the engineer is called from the power house and, if he is fortunate, he locates the valve and the first part of the incident is over.

Or again: Bill and Jim are left some night to put a new pulley on the line shaft. In a moment of absent-mindedness Jim hangs one of their lanterns from a sprinkler pipe and directly below a sprinkler head. A few minutes later they are startled by a sudden forceful rush of water as the head lets go, and tumble and scramble down their ladders in an endeavor to find the night watchman and have the stream shut off. Anywhere from five to twenty minutes may be spent in this search, and meanwhile the water is drenching all of the surrounding machinery and work on the floor in question, and rapidly running down to the floors below. None of the men present appreciates the damage that may be done by water, and thus nothing is done to clean up the machines or work or cover them with oil in an attempt to stop rusting. As a result, when the foreman and superintendent arrive in the morning, a large number of valuable machines are thoroughly drenched and will need immediate overhauling, and a large amount of valuable work must be attended to at once or all of the polished surfaces will have to be refinished and many of the fits will be spoiled.

"Accidents will happen in the best of families," but the wise family is ready for the accidents. The average machinist is apt to be lost when he runs against a piping job. Perhaps a certain amount of mystery is reflected from wiped joints, the making of which is the largest item in the skilful stock in trade of the plumber. But even if this is so, a little intelligent study can locate valves at easily accessible points on all piping systems of the machine shop, and foreman, or others upon whom the responsibility is placed, can know of these valves so that in any case of emergency water, gas, steam, air or any other escaping fluid can be at once shut off before any serious damage has taken place.

A suggestion has been made to the American Society of Mechanical Engineers in regard to establishing a definite code of colors to be used in painting power-house piping, each color distinctive of the use to which the pipe is put. Why cannot every machine shop work out a similar code of its own? so that by following a certain color any pipe can be traced back rapidly to the nearest shut-off valve in case there is occasion for shutting or opening that valve in a hurry.

Another situation that is liable to arise is a break in a pipe line traversing the yard between buildings, or the main supply for such a piping system coming in from the street. After the fact is established that such a leak or break exists, the question is asked "Where is it?" This is immediately followed by another question "Where do the pipes run?" We are perfectly safe in making the statement that the average machine shop has no map of the piping that runs through its yard, and in case of an emergency one can only find the points where such piping enters or leaves the buildings and guess at the course that it takes in running through the intervening ground. No argument is needed to show that such a map should be in existence, showing plainly the direction, size, kind and depth of every pipe devoted to industrial purposes around the plant.

## Factors of Safety in Air-ship Design

It is high time that ordinary engineering knowledge and experience should be used in designing airships. Anyone with even a most elementary knowledge of machine construction cannot fail to notice the crudities of machine design that exist in dirigible balloons and aëroplanes. Yet they fly; but the time has come to begin a systematic improvement of details. The fact that machines are being sold to the public is sufficient proof of the preceding statement.

Probably no one knows just what factors of safety—using that expression in an engineering sense—existed in bicycle construction of a few years ago; or even today for that matter. The bicycle development was a whittling, paring operation in an effort to build the lightest machine possible and still have it usable. Airship development has apparently begun with the lightest construction possible; for, obviously, a machine must be light to fly.

Coupled with this fact which is obvious is another, probably unknown in magnitude by anyone, that airship members are

subject to certain stresses when flying under given conditions. Those stresses must be known and designed for. Six human lives have been lost in airship accidents since the Rheims contests, and while it is impossible to state with authority that an engineering study of details resulting in modifications of design might have prevented the accidents, yet such is the presumption.

So apparent are the crudities of construction that even the daily papers are beginning to recognize and comment concerning them.

We have seen several flights, and attempted flights during the last two years of both aëroplanes and dirigibles and every one was characterized by a condition of unreadiness. Something or other must be tinkered with before the machine could be used. In justice we must say that this applies in much less degree to Mr. Curtiss and his machines than to others.

Consider the folly of a man risking his life in a structure that buckles as soon as he gets into the air and makes an immediate descent necessary. How foolish to use adhesive tape to fasten together important members of an airship structure! How negligent to begin an important flight with a leaking oil tank! How amateurish to make the joints of aëroplanes out of bits of nails, wire and stove bolts!

All these call to mind the nursery jingle about "strings and things and other childish toys."

Still another feature to be considered is safety devices. It has been stated that the cause of the recent explosion of a French army dirigible was the puncturing of the gas bag by the propeller. Would it be impossible to put a suitable guard around the propeller to prevent such an occurrence? And would it be objectionable aside from adding a little weight?

Next year will bring the greatest spectacles in aviation that the world has ever seen, when the contests are held over American soil. It is to be sincerely hoped that before that time a radical trend will take place toward an engineering development of airship design.

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In a report dealing with the resistance of rivets, presented to the Société d'Encouragement, it is noted that the resistance of riveted plates to statical forces or shocks should be borne as much as possible by the adhesion of the plates and the shearing of the rivets figured upon at a minimum. The desirability of standardizing the heads of rivets and regulating the maximum temperature during the process of heating in order to avoid the elastic qualities of the rivets being affected is emphasized.

## Albert J. Perks

A. J. Perks, of the Webster & Perks Tool Company, died at his home in Springfield, Ohio, October 4, of arterial sclerosis, from which he had been suffering for about six months.

Mr. Perks was born in Birmingham, England, in 1851. His father was an exceptionally skilled toolsmith and when Albert was a small child the family came to America. Growing up in an environment of manufacturing industries, the boy's natural mechanical talent was developed and after acquiring a good common-school education, he became a skilled machinist and rose by his own efforts and merit through the ranks of toolmaker, foreman, superintendent and finally became one of the founders of the Webster & Perks Tool Company, of which he has been the head since the death of Mr. Webster sixteen years ago.

Mr. Perks, whom the writer has known

ALBERT J. PERKS

for most of his active life, was notable for the steadiness with which he worked to accomplish his purposes, and his purposes were always creditable to him and were pursued with all due and proper regard for the rights and feelings of others. Endowed with considerable natural artistic ability, this, together with his mechanical tastes and training made him a good machine designer and by his work in that line he has contributed in an important way to the success of many industrial operations, his establishment having turned out many special machines used in manufacturing operations besides its regular and more generally known product.

Besides being a successful manufacturer, Mr. Perks was a highly esteemed citizen and a devoted friend, though his retiring disposition and an inclination to hold himself back instead of pushing himself forward tended to make him less well known than he deserved to be.

Besides his widow, he leaves two grown sons, one of whom, George W., is superintendent of the Springfield works of the American Seeding Machine Company.

## Personals*

Charles H. Speer, formerly consulting engineer with Carr & Speer, New York City, has accepted a position with the Algoma Steel Company, Limited, Sault Ste. Marie, Ontario, to act as an assistant engineer.

Frank Maxant, who has been engineer with the Jones & Laughlin Steel Company for several years has resigned his position in order to become a partner in the engineering firm of Maxant & Co., Chicago, Ill.

W. S. Giele, until recently superintendent of the plant of the Stoever Foundry and Manufacturing Company, Myerstown, Penn., has severed his connection with that company. Mr. Giele is at present devoting his time to special work.

H. F. Brandes, for many years connected with the Bullard Machine Tool Company in the capacity of superintendent, has severed his connection therewith in order to assume the active management of the Springfield Manufacturing Company, Bridgeport, Conn.

H. F. Hoevel has been elected vice-president and secretary of the Wiener Machinery Company, New York City, and has also become a director of the company. Mr. Hoevel was conected with the Siemens-Schuckert Electric Works before coming to this country and has given special attention to the study of iron and steel.

John H. Barr, second vice-president and factory manager of the Smith Premier Typewriter works, has been appointed consulting engineer of the Union Typewriter Company, with headquarters in New York City. Mr. Barr entered the typewriter field with the Smith Premier works in 1903, coming from Cornell University where he was professor of mechanics for a number of years. He is a contributor to our columns and has become widely known in mechanical circles by his contributions to mechanical literature.

## A. S. M. E. Monthly Meeting

A regular monthly meeting of the American Society of Mechanical Engineers was held on the evening of October 12, at which a paper upon the "High Pressure Fire System of New York City" was presented by Prof. R. C. Carpenter, of Cornell University.

Professor Carpenter's paper completely covered the subject in a very interesting manner, and after its reading considerable discussion was brought out in which many of the members participated.

*Items for this column are solicited.

# New Tools and Machine Shop Appliances

## Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

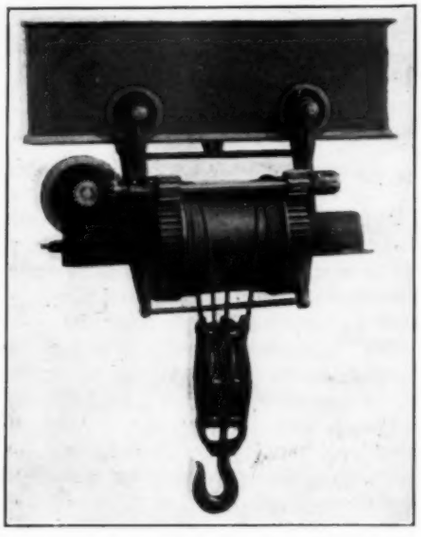
## THE LATEST INFORMATION

### Rasmus Electric Hoist

Among the advantages claimed for this hoist which, as shown, has a capacity of five tons, is the extremely low head room required for a hoist of this size. This is due to the employment of a worm and wheel, driven by an electric motor. This transmits power through the bevel gears and pinions shown to the drum carrying the load. The close head room will be noted when it is stated that on a five-ton hoist it is but 34 inches from the bottom of the I-beam to the bottom of the hook.

The drum of the hoist and the field of the motor are in one piece, the pole pieces from a standard motor being mounted on the inside of the hoisting drum and the armature and brushes suitably connected to drive the worm gear and transmit current to the motor. This does away with all castings and braces necessary to hold a motor in alinement and reduces the total weight of the hoist.

The worm is keyed to the armature shaft which eliminates the necessity of a brake of any kind, as the motor is electrically controlled for speed, and when the motor is not running, all gears are locked in position by the worm, effectually preventing the load lowering when current is shut off from any cause. The whole hoist is only 16 inches wide, 38 inches long overall, and weighs 500 pounds.



RASMUS ELECTRIC HOIST

The worm runs in oil and is provided with suitable thrust bearings. It is built by Gustav Rasmus, 514 West Fifty-seventh street, New York City.

### A New Drafting Table

A new draftsman's table has been added to the line of drawing stands manufactured by The Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass. The table top, which is of well seasoned white pine, may be used as a drawing board and can be tilted to any angle desired. The top is cleated to prevent warping and arranged so as to allow for shrinkage and expansion. Two cast-iron brackets are fastened to the bottom of the board, these swiveling at the end of the spindles. These swivels are clamped by two nuts

A NEW DRAFTING TABLE

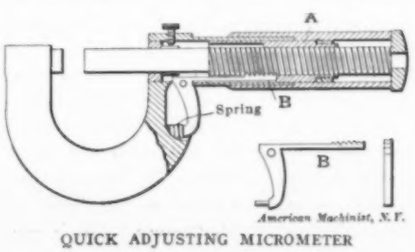
operated by the small hand wheel showing directly below the board.

Universal drafting machines and parallel rules may be used with this board.

The hand wheel at the right raises and lowers the table top by means of two pinions, meshing into racks set in the spindles which are keyed to the hand-wheel rod. In raising and lowering the spindles are always automatically locked in position and yet by simply turning the hand wheel in either direction, the lock is released, making a unique device, which is simple and requires no adjustments. Tests have shown that it will stand up under a load of 1300 pounds before slipping.

### Quick Adjusting Micrometer

As illustrated in the line engraving, the threaded spindle of this micrometer passes

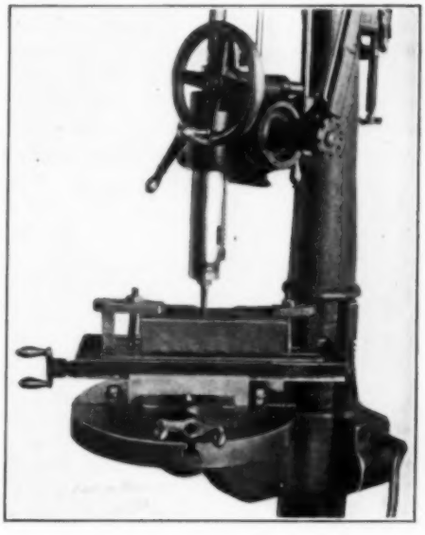



QUICK ADJUSTING MICROMETER

through a nut *A* in the form of a sliding sleeve, which is grooved at the bottom to admit the threaded end of the spacing lever *B*, which will be seen more clearly in the detail. This lever is normally held in engagement with the spindle by a spring under the lower end, and can be readily depressed by the thumb when the micrometer is to be adjusted. Upon depressing the lever the micrometer spindle may be slid along rapidly to any desired point. As the end of the lever *B* fits in the slot in sleeve *A* the latter is prevented from turning when the micrometer screw is operated. There is, as shown, an adjusting nut at the rear end of *A*, and at the front there is a screw operating upon a bush which is split to enable it to be gripped upon the spindle. The maker is Henry O. Costello, 87 Oakland avenue, Providence, R. I.

### For Milling on an Upright Driller

As can be seen from this illustration this is a very substantial work table with



BLISS MILLING ATTACHMENT FOR DRILL PRESSES

slides in both directions to be used on a drilling machine or anywhere else that such a method of holding and moving work is desirable. This makes vertical milling an easy matter in any substantial drilling machine.

It bolts direct to the drill table and presents a surface 8¾x21¼ inches for fastening work to, with a movement of 9 11/16 inches lengthwise and 5¾ inches crosswise. No swivel is provided as the

table can be swung for angular work and there is one less joint without it, getting the work down closer to the table.

All bearings are carefully scraped in, nuts for the screws are large and made of bronze, micrometer collars reading to 0.001 inch, being provided for ease in adjustment. It weighs 110 pounds.

With a drill having a movable head it would be even more useful than as above. It is made by the E. C. Bliss Manufacturing Company, 91 Sabin street, Providence, R. I.

## The Social Side of Industrial Education

By P. Kreuzpointer*

I have been much interested in the remarks and suggestions concerning the necessity and manner of establishing trade schools in order to relieve the imperative needs of the machine-building trade in particular, and industries in general, as they have appeared from time to time in the American Machinist.

Various reasons are advanced by different parties as to the causes for the disappearance of the skilled mechanic—specialization, labor unions, schools, poor pay, reluctance to soil one's hands, disrespect among the people for the man who earns a living by manual labor, and perhaps other reasons, are given. Probably one reason is as good as the other.

Society of today is so complex and the forces which shape it into a delicate structure, and produce phenomena of a diversified nature, are so varied and variable that no single reason can be assigned as the one that influences the action of large bodies of citizens in their decision as to what is best for their children to do. We have not yet attained in this country to a distinct stratification of society. The transition from one stratum to another is still comparatively easy, though more difficult than a generation ago.

Thus the trend of the movement of society is constantly upward. In this country where material possessions count, as yet, for more than moral or intellectual or esthetic superiority it is earning power which is sought after by the young people. To get up in the social scale, which means the ability to display, is the universal tendency. But to satisfy this universal craving for social recognition and display requires one or both of two things: money, and station in life. Money may be earned or stolen—grafted is the modern term—station may be acquired by a coating of gentility in the shape of an occupation where one's hands need not be soiled, and where a superficial smattering of intellectual acquirements are the key to social superiority.

*Chairman, committee of industrial education, American Foundrymen's Association.

### Social Superiority Is Supposed to Accompany a Knowledge of Latin

Of all the students entering the public high schools, more than 50 per cent. take Latin. Only 13 per cent. of those who enter high school graduate. A little over 90,000 students in 1908, and of these less than one-third take the college preparatory course who really need Latin for their life's work School men admit that this preponderance of the study of Latin over any other study in the high school is solely due to the supposed social distinction accorded to the possessor of a smattering of Latin.

This traditional social distinction is accorded the possessor of a fragmentary knowledge of Latin at the present time because in the pioneer days of our republic the physician, lawyer and minister, who necessarily had command of Latin, gave tone and leadership to society, and this explains why so many rather choose a vocation that is overcrowded and half starving the incumbents because such vocation carries with it the tradition of intellectual superiority and social distinction. Here we have one reason why boys do not care to learn a trade which, when I came to this country in 1866, was still largely considered menial work, but lost that social stigma during the following 30 years, only to reappear under a new form in the modern industrial organization where there is danger that the mechanic become nothing else but a will-less and soulless automaton.

This pushing-up process in the endeavor for social distinction is naturally intimately connected with the desire to earn money to be able to display, to keep up, often enough, a higher standard of living than one's means warrant under judicious management. This ability to earn what is wanted or expected is not realized under tightening economic conditions and intermittent employment, except under favorable conditions and with the advantage of a good industrial schooling; even that latter requisite is not always a guaranty for success in that direction. In this respect you are right in your editorial, on page 89, when you say that "First, the pay is too small, and second, the instruction is too poor." So in many instances a—if the expression be permitted—counterfeit social distinction with a genteel occupation and starvation wages is preferred to a better-paying mechanical occupation.

### Influence of Mental Relaxation

But, as in all complex social phenomena, another reason for the lack of willingness to learn a trade may be found in the fact that in our happy-go-lucky way we have neglected to pay attention to the fact that, as in a period of prolonged physical relaxation we lose the power for continued, severe physical exercise, so likewise prolonged mental relaxation produces a state of mental dormancy, the consequences of which upon further requirements of activity are even harder to overcome than the consequences of physical relaxation. All the more difficult is it to overcome the consequences of this mental relaxation if the break in mental activity occurs in the formative period, as in boys and girls of the grammar grade and high-school age, because relaxation of mental activity at that age means relaxation and standing still in the acquisition and strengthening of will power, the formation of strength of will and exercise of will being essentially a mental process.

The boy leaving his school at 13 or 14, with perhaps only a fifth- or sixth-grade education, and having no opportunity or incentive whatever, is in no frame of mind whatever to "knuckle" down to the serious business of being an attentive apprentice with its necessary discipline and the freedom and earning power of a journeyman a long ways off for the impatience of youth. If he does enter a shop to learn a trade, more or less reluctantly, he is never able, with few exceptions, to make up the loss of mental activity, due to the relaxation of mental effort on leaving school, with "nothing-doing" for two years or more. I have had opportunity to closely observe the degenerating effects of this break in mental activity, due to lack of public educational facilities, on hundreds of young men and boys. These facts and conditions, and others not touched here, deserve the earnest attention of all who, in any way, try to contribute to the solution of the problem how to give our industries the needed help of skilled labor.

### Low Apprentice Wages are Inherent in our Present Industrial System

It has been suggested that wages of the apprentice are too low, hence not sufficiently attractive to induce boys to learn a trade. But while this suggestion sounds reasonable its carrying into practice to any extent is opposed by the fact that extreme specialization does not demand any extended preparation for learning the specialized part, and what little is to be learned is soon acquired by the average bright American boy.

This is why the boy of today is not considered worth more than he was 40 years ago. Forty years ago the average boy was not considered worth more because a certain amount of time and material was wasted before he was broken in. Today he is not worth more because in a specialized trade he needs so little preparation that a more expensive beginner is not profitable from a purely economic standpoint. And those positions which require some training to begin with, and where the apprentice could claim more remuneration, cannot be filled for lack of that training. Forty years ago the apprentice was rated low because of the loss of time and material in the shop occasioned by the boy's inexperience. For

reasons well understood the duty to gain this preliminary experience is being thrown upon the school and where that schooling is wanting the boy is no better off today than he was 40 years ago because the modern shop cannot and will not take the trouble of furnishing preparatory training, where such is required by conditions, as it was furnished by the shop 40 years ago, before payable results were obtained.

### Experience of Girard College

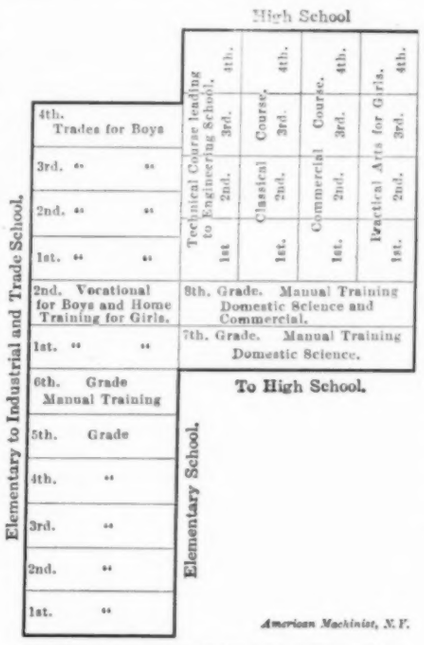
This condition is forcibly and plainly illustrated by the plan followed at Girard College in Philadelphia. In founding the school Stephen Girard willed that the boys had to be apprenticed out by the institution at the end of their schooling. But when modern industrial conditions made this clause of the will impracticable, in order to live up to the spirit of the will, Girard College assumed the burden of preliminary training. When the business men of Philadelphia were asked to take these boys it was found that their immediate compensation, on entering an occupation, was rated according to the boy's preliminary preparation for the occupation he was to enter. The weekly pay offered by the business men varied from $3 to $7 and I was told of one instance where $9 a week was offered for a boy who had not yet left the school.

If this lesson from Girard College has any value for us outsiders it teaches us that preliminary training is required and has value in any business, and since this preparation cannot be acquired in the modern shop, store or office, the public-school system must help us, not to turn out finished craftsmen, but to turn out boys and girls prepared in the fundamentals and underlying principles of whatever occupation they may choose.

### Influence of Hero Worship Fostered by the Schools

In all of our argumentation of the causes why the American boy hesitates to enter shop and factory we seem to have overlooked one factor. In the boy's imagination he pictures himself as part of the political power of the country. In school books and newspapers his youthful ambition is aroused by tales of those who rose to high political office and power, or to financial wealth, or to social distinction from a low social station in life. These examples are held up to him as the ideals to be followed by all good citizens and ambitious boys. He is constantly taught to worship the heroes of finances, of the battlefield, of social position, of political partizanship. What wonder the everyday, plain, sober, plodding, monotonous duties of the everyday life of a mechanic do not appeal to him. He sees "there is no money in it," he sees that he will be only one of a herd of 500 or 1000, or 10,000 without any prospect whatever of a realization of school books, or newspaper, or Fourth of July speech ideals. He hears many tales how the little bosses in factories abuse the men, with or without the knowledge or consent of the managing officers, as the case may be. He hears how, generally, there is no redress against such abuses except at the risk of being discharged, or "frozen" out, or life made hell for the one who dares to complain. The boy has never been taught that the honest, industrious life of the industrial worker has its duties and responsibilities and its contributions to the general stock of common welfare, as well as the life of the heroes. The boy hears a great deal of cant about the dignity of labor, but sees those given the preference and lionized who do not labor, or if they do, are careful not to soil their hands.

Can we blame the boy if his ideals are shattered that way and he reluctantly enters shop and factory, or declines to enter at all, irrespective of the question of compensation? Conditions are pressing for a solution of the problem; our industries must have skilled men, not only skilled in the manipulation of tools, but skilled in the use of their judgment, their natural abilities of taking hold and making the best of their opportunities. To this end we must broaden the boy's vision. We must give him a perspective view of life instead of holding up before his youthful vision a long, level, monotonous stretch of country at the farthest end of which loom up the exalted visions of a few over-glorified men of wealth or ephemeral achievements. To attain this end we must bend our future education.




SCHEME OF CINCINNATI PLAN FOR HIGH SCHOOL AND TRADE SCHOOL COURSES

### Manufacturers Can Do Much Now if They Will

But before we can expect the fruits of such an education the manufacturers of a city, large or small, can go together and make the best use of what facilities there are on hand, in a similar manner as the manufacturers did in Cincinnati, plan and prospectus of which follow; only such a plan should include all industrial workers and not only metal trades.

If the workingmen's confidence is sought and the situation is explained to them they will likely be found willing to coöperate in whatever way it is necessary. If the boys are made to see that the united sentiment of the community needs their service in a given line of work, if they see that there is a steady, if not a brilliant, future before them, if they are made to feel that they are not merely to be one of a herd to be driven by some overbearing underling who wants to be better than his master, and in addition be exploited by the politician for mercenary purposes, then they will be more willing. Much of this kind can be done at once, provided there is co-operation between the school authorities, those needing skilled labor and the taxpayers. Concessions and sacrifices have to be made on all sides, of course. No social movement of this kind can be one-sided if it is to be successful, but during all of my 40 years of educational work and agitation for industrial education I have found the American people always fair in the end, provided they can have confidence in the sincerity and honesty of the project presented for the people's approval.

It goes without saying that the proposed educational campaign is to have a broader basis than merely the acquisition of a certain amount of manual dexterity for so much wages. What that basis might be is another chapter.

### Cincinnati Continuation School for Machine-shop Apprentices

After a meeting with the Manual Training Committee of the Board of Education and a committee representing the Metal Trades Industry, the following general method of operation was determined upon:

The manufacturers agreed to provide the boys for the school and to pay them for the time they attend; the Board of Education to provide the teachers, school, and necessary apparatus.

The school is to be considered a part of the Department of Manual Training and under the supervision of the manual-training supervisor. The teachers shall be subject to such of his directions as shall be authorized by the superintendent of the schools and shall be open to his inspection and examination.

The course shall in general be technical with as close application as possible to the shop work of the boys. It shall be the aim to develop continuous courses along the following lines:

1st. A period each day for general shop questions, shop practice, economic questions and civic questions. This work may be either individual or class discussions.

2d. Shop arithmetic and other mathematics.

3d. Mechanics, beginning with the simple elements of machines. Mathematics and mechanics to be taught together as far as convenient.

4th. Free-hand drawing, designing, drafting.

5th. Practice in spelling, writing, reading in connection with the story of industries.

It shall be the aim to develop a course in each of these subjects that shall proceed connectively to definite ends. A series consisting of all the lessons in each subject shall be carefully preserved by at least one student of each group to form a basis for inspection and for a course of study. It is expected that the course will be of four years' duration, corresponding to the four years of apprenticeship, but advanced students may complete the course in less time.

The first duty of the instructor shall be to classify the apprentices into groups according to their mental attainments, getting each group as nearly homogeneous in proficiency as possible so that the general character of work of the pupils of a group shall be somewhat the same. In the first course noted above, shop questions, individual instruction and much freedom is expected; in the other courses definite results are expected and necessarily much more uniformity of work, not, however, to the exclusion of individual inspection where the instructor is able to give. The progress of each pupil must be looked after individually in all subjects.

The morning session shall be from 7:30 to 11:30; the afternoon session from 1:30 to 5:30, subject to change by the superintendent. There shall be no Saturday afternoon session. The instructor shall be granted two half days a week to visit shops upon pay.

He shall report to the employers, upon blanks prepared, the attendance of his students each day and shall keep a register of the same for inspection of the supervisor of manual training and shall make such reports as are required by the superintendent. The school shall continue 48 weeks in the year, five and a half days a week, providing the attendance justifies it. Groups of students should as a rule contain as a minimum, 14, and as maximum, 20 to one instructor. General visitors other than members of the Board or the Industrial Committee shall be admitted only upon permit from the superintendent or supervisor of manual training. This is ordered to prevent the annoyance which is likely to come from curiosity over any new movement.

## Forthcoming Meetings

American Electrochemical Society, autumn meeting, October 28 to 30, New York City. J. W. Richards, Lehigh University, South Bethlehem, Penn., secretary.

National Gas and Gasolene Engine Trades Association, Chicago, November 30, December 1 and 2. La Salle hotel. Albert Stritmatter, secretary, Cincinnati, O.

American Society of Mechanical Engineers, annual meeting, New York City, December 7-10. Calvin W. Rice, secretary, United Engineering building, New York City.

National Society for the Promotion of Industrial Education, annual convention, December 1, 2 and 3, Milwaukee, Wis. J. C. Monaghan, secretary, 20 West Forty-fourth street, New York City.

## Business Items

The Irondale Steel Company, Fort Townsend, Wash., said to be the first steel plant to be built west of the Rocky mountains, has placed a contract with Tate, Jones & Co., Inc., Pittsburg, Penn., for the complete oil-burning equipment for the two 20-ton open-hearth furnaces.

H. F. Brandes, formerly superintendent of the Bullard Machine Tool Company, has purchased the business and plant of the Springfield Manufacturing Company, of Bridgeport, Conn., and will take active charge as president and general manager at once. They will continue to manufacture the same line of grinding machinery and abrasive wheels as heretofore.

## Business Opportunities

Stork Bros., Tyler, Minn., will build an egg-packing plant.

R. C. Bogerson, Virginia, Minn., will erect a blacksmith shop.

C. J. Henn, Stevens Point, Wis., will establish a cheese factory.

The Howard Paper Company, Urbana, Ohio, is building a new mill.

The Crivitz (Wis.) Flour Mill Company will erect a new plant.

The Wilcox Comb Company, Keene, N. H., will erect a new factory.

The Shields (Mont.) Milling Company will erect flour and grist mill.

The Hoeppner Trunk Company, Eau Claire, Wis., will erect a factory.

The Rapid City (S. D.) Packing Company will erect a $15,000 plant.

The Watab (Minn.) Pulp and Paper Company will build an addition.

The Milwaukee (Wis.) Coke and Gas Company will build a new shop.

George Sodola, Coleman, Wis., will erect a cheese factory at Klondike, Wis.

The Duluth (Minn.) Brewing Company will erect a cold-storage building.

The Keystone Worsted Company, Rochester, Minn., will erect a knitting mill.

The Montello Paper Box Company, Brockton, Mass., will erect a new factory.

The plant of the St. Paul (Neb.) Canning Company was burned. Loss, $20,000.

The town of Delmot, S. D., is figuring on the erection of an electric-light plant.

The S. C. Shannon Company, Appleton, Wis., will erect a cold-storage plant.

The plant of the Hartford (Wis.) Plow Company was burned. Loss, $50,000.

The New Haven (Conn.) Clock Company will add another story to its building.

The Rapid City (S. D.) Creamery and Produce Company will erect a new plant.

The Gas Traction Company, Minneapolis, Minn., will erect an addition to its shop.

The Badger State Shoe Company, Madison, Wis., will build an addition to its plant.

The Durand (Mich.) Light and Water Company will install an additional engine.

The Linton City (Ind.) Lighting Company will rebuild its power house next spring.

The plant of the Henderson (Ky.) Chair Company was burned. It will be rebuilt.

The Fairmount Creamery Company, Crete, Neb., will erect a tool and machine shop.

The Springfield (Ohio) Heat, Light and Power Company is building a new plant.

The North American Storage Company, Watertown, S. C., is to erect a new plant.

The Russell Commission Company, Dickinson, N. D., will erect a cold-storage plant.

The International Stock Food Company, Minneapolis, Minn., will build an addition.

The Levin Furniture Company, Minneapolis, Minn., will build an addition to its factory.

M. & J. Schuling, Grand Rapids, Mich., makers of tinware, are to erect a new factory.

The Western Grocer Company, Marshalltown, Iowa, will establish a canning factory.

The Marshalltown (Iowa) Trowel Company will erect an addition to its blacksmith shop.

The Milford (Mass.) Iron Foundry Company has erected a large addition to its plant.

T. N. Vail has begun work on building for a new water-power electric plant at Lyndon, Vt.

The Reickhoff Box Company, New Duluth, Minn., will remove its plant to S. Superior, Wis.

E. W. Bunker, Spooner, Wis., will establish a plant for manufacturing lead-pencil sharpeners.

The C. H. Cowdry Machine Company, Fitchburg, Mass., is erecting an addition to its plant.

The Citizens' Light and Power Company, Xenia, Ohio, intend building a new plant next spring.

The Norwich (N. Y.) Brewing Company expect to install a 80-horsepower boiler this winter.

The Royal Steam Heater Company, Gardner, Mass., is having plans drawn for a new factory.

The Standard Mirror Company, Buffalo, N. Y., is having plans prepared for a new factory.

The Marlin (Tex.) Ice and Electric Light Company will rebuild a plant at a cost of $70,000.

The German-American Sugar Company, Paulding, Ohio, will erect a new sugar factory.

W. J. Doyle, Rome, N. Y., is putting up a new building to be used as machine shop and foundry.

The United States Can Company, Cincinnati, Ohio, will build a $30,000 addition to its plant.

J. W. Murkland, Barton, Vt., is fitting up a new machine shop and garage at Crystal Lake hotel.

A. Wyckoff & Son Company, of Elmira, N. Y., will build a wood-pipe factory in Alexandria, Va.

The Adams & Rice Dairy Machine Company, Buffalo, N. Y., is erecting an addition to its plant.

The Wisconsin Sugar Company is planning the erection of a beet-sugar plant in Fond du Lac, Wis.

The Riverview Bronze and Manufacturing Company, Buffalo, N. Y., will build a two-story factory.

The Lyndonville (Vt.) Garage will install new machines for repair work. E. J. Blodgett, proprietor.

The Granite City Iron Works, St. Cloud, Minn., will remodel its plant and install some new machinery.

The Raymond Manufacturing Company,

Middletown, Penn., is erecting an addition to its stove plant.

The Precise Company, of Indianapolis, Ind., manufacturing automobile parts, will move to New Castle, Ind.

The Atlas Tack Company, Fairhaven, Mass., will build an addition, doubling the present size of its plant.

The American Valve and Meter Company, Cincinnati, Ohio, will erect a $25,000 addition to its plant.

The machine shop of the Nichols & Langworthy Machine Company, Hope Valley, R. I., was destroyed by fire.

The Pitcher & Paulson Shoe Manufacturing Company, Sparta, Wis., will double the capacity of its plant.

The International Acheson Graphite Company is erecting another addition to its plant at Niagara Falls, Ont.

Sebring Brothers, owners of the Sebring Pottery Company, Sebring, Ohio, will build an automobile factory.

The Smalz-Goodwin Shoe Company, Philadelphia, Penn., has begun the erection of a new twelve-story factory.

The Arthur T. Crist Publishing Company, Cooperstown, N. Y., will install a 200-horsepower producer-gas engine.

The Clarage Foundry and Machine Company, Kalamazoo, Mich., will erect a new foundry and machine shop.

Osgood Bradley & Sons, Worcester, Mass., will build a new car-manufacturing plant in Greendale to cost $500,000.

The Robt. A. Johnson Company, Milwaukee, Wis., will erect a large addition to its confectionery and baking plant.

The Hackney Wagon Company, Wilson, N. C., is erecting an addition to be used as a spring-wagon department.

The main building of the Webster (N. Y.) Basket Company was destroyed by fire, causing a loss of about $15,000.

Harry Hamilton, of the Hamilton Garage Company, Greensburg, Ind., and others, will establish an automobile factory.

The John H. Allan Seed Company, Sturgeon Bay, Wis., will install an electric motor in its plant in the near future.

The Phœnix Manufacturing Company, Eau Claire, Wis., will build an addition for the manufacture of logging machinery.

The Manufacturers' Foundry Company, Waterbury, Mass., has awarded contract for erection of an addition to its plant.

The Canton (Ohio) Drop Forging and Manufacturing Company contemplate to soon commence erection of a machine shop.

W. R. Follmer will build a machine shop at Ferry and Lake streets, Milwaukee, Wis., to cost $30,000, including machinery.

The Barnes Gear Works, Oswego, N. Y., will move into its new factory about January 1 and install a number of new machines.

J. C. Jones, Iron Mountain, Mich., is interested in a project to erect a $1,000,000 steel plant at either Escanaba or Menominee.

The Nortmann & Duffke Foundry Company, Milwaukee, Wis., is building an addition to be used for the manufacture of pressed-steel tanks.

The Automatic Cradle Company, Stevens' Point, Wis., is building an addition to its plant for the manufacture of milking machines.

The Norwich (N. Y.) Gas and Electric Company expect to replace two of its boilers with a large 250-horsepower boiler in the near future.

The machine shop and other buildings of S. C. Fredericksen, Cobden, Minn., manufacturer of agricultural implements, etc., were burned.

The Viscoloid Company, Leominster, Mass., will build a new machine shop and also two buildings for manufacturing and storage purposes.

The Dixie Culvert and Metal Company, of Atlanta, Ga., will establish a plant at Baton Rouge, La., for manufacturing metal culverts, etc.

Considerable damage was done to the plant of the Auburn Heat, Light and Power Company, Auburn, N. Y., by the bursting of the water heater.

The McKinnon Chain Company, a branch organization of the McKinnon Dash Company, of Buffalo, N. Y., will erect a factory in Tonawanda, N. Y.

The Great Northern Development and Land Company, Duluth, Minn., will erect a power house at Coon Creek Junction on the Mississippi river to cost $1,200,000.

The Eclipse Ore Reduction Company, Minneapolis, Minn., manufacturing ore crushers, etc., expect to erect a factory in the near future, machinery now being built by outside parties.

The New Castle (Penn.) plant of the Standard Steel Car Company is to be rebuilt on a much larger scale for the purpose of engaging exclusively in the building of street steel cars.

## New Incorporations

Berkley Foundry and Structural Company, Norfolk, Va. Capital, $25,000. A. J. Cuthriell, Portsmouth, Va., president.

American Malleable Range Company, St. Louis, Mo. Manufacture ranges, heaters, etc. Incorporators, Jacob Caplan, H. Simpkins, etc.

Elm Manufacturing Company, East Orange, N. J. Manufacture jewelry. Capital, $125,000. Incorporators, F. J. Meerlender, H. Picking, etc.

Jackson Paper Company, Sanquoit, N. Y. Manufacture paper. Capital, $500,000. Incorporators, O. Groat, M. H. Hubbard, H. F. Jackson, Utica.

Elby Rotary Engine Company, St. Louis, Mo. Manufacture machinery, etc. Capital, $100,000. Incorporators, J. H. Tulley, P. R. Fitzgibbon, F. J. Curran.

Mono Motor Car Company, Elizabeth, N. J. Manufacture motor cars, motor boats, etc. Capital, $300,000. Incorporators, W. H. Ward, H. T. Eaton, C. Roberts.

The Ronda Paper and Linen Mills, Camden, N. J. Manufacture linen, paper, pulp, etc. Capital, $100,000. Incorporators, R. E. Noah, C. D. Byrd, J. H. Billings.

Venn-Severin Manufacturing Company, Chicago, Ill. Manufacture engines and machinery. Capital, $25,000. Incorporators, T. H. Venn, F. N. Severin, H. L. Venn.

Fidelity Motor Car Works, Sycamore, Ill. Manufacture automobiles and accessories. Capital, $25,000. Incorporators, F. C. Brinkley, Byron J. Snow, J. F. Waters.

Pawtucket Tool Company, Pawtucket, R. I. Manufacture tapping chuck, mechanics' tools. Capital, $100,000. Incorporators, E. D. Thompson, J. N. Alexander, J. A. Dalton.

New York Igniter Company, New York. Manufacture lighting and heating devices. Capital, $40,000. Incorporators, Jas. C. Wormby, C. R. Sherlock, A. S. Curlett.

The Greenstreet Box Machine Company, Crawfordsville, Ind. Manufacture machines for making wire-bound folding boxes. Capital, $200,000. Col. I. C. Elston, president.

Spencer Motor Company, Rahway, N. J. Manufacture automobiles, etc. Capital, $125,000. Incorporators, C. G. Willis, Brooklyn, N. Y.; H. Albisser, A. G. Spencer, Rahway.

Newark Auto and Engineering Company, Newark, N. J. Manufacture motor vehicles, engines, machinery. Capital, $25,000. Incorporators, Alex Traudt, Sr., Alex. Traudt, Jr., etc.

# Want Advertisements

*Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.*

## Miscellaneous Wants

Caliper catalog free. E. G. Smith, Columbia, Pa.

We solicit your representation. Maxant & Company, 222 So. Canal St., Chicago, Ill.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Fine, experimental work and tool designing and making a specialty. Benj. O. Butler, Taunton, Mass.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emery & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Metal specialties manufactured, models, dies and special machinery; inventions perfected. Villinger Mfg. Co., Williamsport, Pa.

Wanted—Purchaser for No. 2 Farwell milling machine, Grant hobbing machine and Gisholt tool grinder; all practically new and in A-1 condition. Box 755, AMER. MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Machinists and engineers blueprint chart of United States Standard pipes and tapping sizes from ⅛" to 10" pipe. Price 10 cents per copy postpaid. Liberal discounts to shop agents. Address Charles Kuderer, Woodlawn, Penn.

## Situations Wanted

*Classification indicates present address of advertiser, nothing else.*

ILLINOIS

Wanted—Position as mechanical draftsman or assistant superintendent; have had four years' experience in designing and detailing of special, paint, automatic can-making machinery and gearing; have also had four years of general machine-shop experience and have also been in charge; references. Box 782, AMERICAN MACHINIST.

MASSACHUSETTS

Production engineer for shop manufacturing valves, fittings and piping; wide experience in designing, increasing production and reducing costs; can show results. Box 745, AMERICAN MACHINIST.

Factory superintendent at present engaged, wishes to make a new connection, preferably New England States; technical education as mechanical engineer; 18 years' manufacturing experience on automobiles, guns, sewing machines, special machinery and similar work. Box 798, AMERICAN MACHINIST.

NEW JERSEY

Mechanical draftsman wishes position. Address Box 795, AMERICAN MACHINIST.

Thorough mechanic with technical training, as assistant to superintendent; references. Box 802, AMERICAN MACHINIST.

Mechanical engineer desires position; experience in power plant design and installation; best of references. Box 771, AM. MA.

Mechanical engineer, chief draftsman and designer, experienced on pumping machinery and steam engineering, is open for responsible position. Box 714, AMER. MACHINIST.

NEW YORK

Draftsman, 12 years' experience, seeks position. Box 803, AMERICAN MACHINIST.

Wanted—Position as head of production or stores departments by young man with ten years' experience; best references. Box 806, AMERICAN MACHINIST.

Young foreign graduated mechanical engineer, having had practice in own country, wishes to change position; wants position as designer offering a future. Box 805, AM. M.

Superintendent, experienced on special automatic machinery for sheet metal, wire forming, screw machines, turret lathes, pneumatic tool and general machine work; would accept position as superintendent, designer, improver or general foreman. Box 800, AM. MACH.

Salesman—Machine tool salesman as sales manager, having 15 years' experience, both in the manufacture and selling of machine tools; competent judge of condition and value of second-hand, and familiar with all makes in the United States; can give best of reference. Box 790, AMERICAN MACHINIST.

OHIO

Technical graduate, 20, desires position as mechanical draftsman; one year's experience in drawing room; had shop practice during studies; Cincinnati preferred. Box 799, AMERICAN MACHINIST.

PENNSYLVANIA

Mechanical draftsman; age 23; technical graduate; five years' shop and three years' drawing-room experience, desires position with first-class firm. Box 807, AMER. MACHINIST.

FOREIGN

English youth desires start as apprentice; preferably with firm making electric generating plant; opportunity to attend technical school; northwest; state wages. Box 804, AMERICAN MACHINIST, 6 Bouverie St., London.

## Help Wanted

*Classification indicates present address of advertiser, nothing else.*

CANADA

Thoroughly competent young man, with mechanical and executive experience, to take an interest with a view of purchasing a fully equipped machine shop, located in large city in Western Washington; plant is in operation, making gasolene engines, canning and saw-mill machinery, besides doing general jobbing work; splendid opportunity for the right man, with a few thousand dollars, anxious to acquire a business for himself, that will be a money maker from the start. Answer stating age, nationality, experience and references. Answers will be treated confidentially. Box 700, AMERICAN MACHINIST.

CONNECTICUT

Wanted—A first-class toolmaker on jig and fixture work. Box 621, AMER. MACHINIST.

Wanted—Experienced mechanical draftsmen for detail work, in a concern manufacturing general rolling mill and hydraulic machinery; state age, experience and salary expected. Box 796, AMERICAN MACHINIST.

Wanted—In a large New England manufacturing plant, an experienced millwright and carpenter, familiar with heavy work, to act as foreman of carpenter's shop (about twelve carpenters) and to take charge of all repairs and the erection of new buildings and machinery. Address "F," AMER. MACH.

ILLINOIS

Man wanted, experienced in running large radial drills on heavy work. Box 708, AM. M.

INDIANA

Wanted—Machinists, five filers and fitters, five lathe men and three patternmakers to work on radiator patterns. Address, The Logansport Radiator Equipment Co., Logansport, Indiana.

KENTUCKY

Wanted—A man who can act as foreman in machine shop doing specialty work; must be capable of managing men so as to bring out their maximum capacity; none except competent and very energetic men need apply; shop non-union; past and present references required. Box 789, AMERICAN MACHINIST.

MASSACHUSETTS

Designer and draftsman; experienced on rotary printing presses and folders. Box 797, AMERICAN MACHINIST.

Wanted—First-class draftsmen. Apply Supervisor of Drafting Rooms, General Electric Company, Pittsfield, Mass.

Wanted—Competent man to take charge of tap threading department, also foreman for inspection department. Apply, with references, Wells Brothers Co., Greenfield, Mass.

Tool steel salesman wanted for New England; preference given a young man thoroughly familiar with tool making and general machine-shop practice. Address P. O. Box 1188, Boston, Mass.

Wanted—Sheet steel salesman for New England territory; good position for young man who has thorough knowledge of various qualities and finishes of soft steel sheets and strips. Address Wheelock, Lovejoy & Co., Boston, Mass.

Mechanical draftsman wanted for 6 months; one with experience on several different kinds of machines and capable of working out ideas quickly and accurately; man under 40 preferred, who has had shop training; salary, $25 a week. Box 780, AMERICAN MACHINIST.

Rate Setters Wanted—Must have had experience with time study method, using stop watches; opportunities for advancement in Massachusetts plant building engines, marine specialties, etc.; state age, experience and salary expected. "R. S.," 24, Box 167, Boston, Mass.

Wanted—Applications from erectors, layout men, production men, brass finishers, machine and hand molders, and operators for lathe, planer, drill, turret machines, boring mill, etc.; heavy and light work. Address Dept. 54, Blake & Knowles Steam Pump Works, East Cambridge, Mass.

MICHIGAN

Two first-class gear men wanted for day or night work; state age, experience and wages. Buick Motor Co., Flint, Mich.

Wanted—Men with first-class experience on Brown & Sharpe and Acme automatic screw machine; none but first-class men need apply. Box 740, AMERICAN MACHINIST.

Wanted—A first-class lathe hand; must be thoroughly familiar with the Lodge & Shipley patent headstock lathe and capable of instructing operators; state experience, age and wages expected. Apply Buick Motor Co., Flint, Mich.

Wanted—An expert screw-machine operator to take the position of assistant foreman in a department of about fifty machines consisting of Jones & Lamson's, Acme automatic, Gridley and Cleveland automatic. Box 775, AMERICAN MACHINIST.

Wanted—Manufacturing superintendent for 2-cycle marine engine department; must possess energy and be capable of producing a maximum and accurate output; none but thoroughly capable and experienced need apply; give full details first letter. Box 793, AMERICAN MACHINIST.

Wanted—Pattern shop foreman; by one of the large up-to-date automobile factories in the middle West; a man who is thoroughly versed in both wood and metal; also gated, plate, rockover, striping plate and other molding machine patterns; must be a man who is temperate, of good principles, and has had a large experience; an excellent position for the right man; state age, experience, present employer, salary wanted and full details; communications strictly confidential. Box 781, AMERICAN MACHINIST.

MISSOURI

Foreman diemaker, experienced on sheet metal dies of all descriptions. Swaine Co., St. Louis, Mo.

Energetic machine tool foreman producing gas-engine parts; state salary, age, experience, etc. Write fully, time is important. Witte Iron Works Co., Kansas City, Mo.

NEW HAMPSHIRE

Wanted—A first-class machinist for setting up and assembling machine tools; opportunity for advancement to man with experience on similar work and capable of handling men; give age, experience and wages expected. Box 743, AMERICAN MACHINIST.

NEW JERSEY

Wanted—First-class machinists; no labor troubles. Box 768, AMERICAN MACHINIST.

Wanted—Chief draftsman. Address Thomas A. Edison, Edison Laboratory, Orange, N. J.

Wanted—A first-class operator on Brown & Sharpe automatic screw machine. Box 773, AMERICAN MACHINIST.

Experienced mechanical draftsmen, familiar with machine details, building work, etc.; state age, salary, previous employers and experience. The Celluloid Co., Newark, N. J.

Tool draftsman wanted; must be man well up on tools for small duplicate work; state experience and wages expected; also age and references. Box 808, AMERICAN MACHINIST.

NEW YORK

Wanted—Experienced draftsmen; state age, experience and wages expected. Box 757, AMERICAN MACHINIST.

Wanted—A draftsman on power pump work; give reference, age and salary desired. Box 785, AMERICAN MACHINIST.

Wanted—Draftsman familiar with design and construction of steam hammers. Write giving references and stating salary expected. Box 784, AMERICAN MACHINIST.

Toolmakers wanted; first-class men experienced on jigs, fixtures and fine gages for close small work. State age, experience in detail, and wages expected. Remington Arms Company, Ilion, N. Y.

Wanted—Machinists, toolmakers, lathe hands, screw-machine hands, milling-machine hands and motor assemblers; steady position to desirable characters. Maxwell-Briscoe Motor Co., Tarrytown, N. Y.

Floor salesman for machine and bench tools; one with machine shop experience preferred; must understand uses to which tools are put; permanent position and advancement for right man; state age, experience, salary expected and references. P. O. Box 2094, New York.

Wanted—General foreman for large manufacturing plant building a line of sheet metal auto bodies and frames; must be a man who is now employed and is holding a similar position; must be aggressive and be able to produce the very best results; no other need apply. Address by letter only, "Sheet Metal," Care Seaman, 30 W. 33d St., New York City.

Wanted—A speed boss, one who knows the possibilities of high-speed steel and can show others; if you are not familiar with these requirements don't answer; we want an aggressive man who has had experience in the above and to the satisfactory man a first-class permanent position is open; send references which will be investigated, and salary required to Box 786, AMER. MACHINIST.

We want a good all-round mechanic to demonstrate high-speed steel to produce maximum results on all machine tools; a good position is open for the man who has had several years' experience and can show us a saving in quality and quantity of work; send references, which will be thoroughly investigated, experience and salary required to Box 787, AMERICAN MACHINIST.

Wanted—A first-class machine-shop foreman in shop employing 100 to 150 men; one who can produce a maximum of accurate work and who knows how to use high-grade steels; must be aggressive, up-to-date in modern methods and a good executive; a first-class position is open to the man who can fill the bill. Send full particulars, salary and references, to Box 788, AMERICAN MACHINIST.

OHIO

Machinist. 201 Nicholas Bldg., Toledo, O.

Wanted—Manager, who can obtain some capital, for modern machine works, running day and night, located in Ohio. "Engineers," Box 759, AMERICAN MACHINIST.

Wanted—Several first-class draftsmen thoroughly familiar with designing steam hammers. In applying state age, experience and salary desired. Box 791, AMER. MACHINIST.

Wanted—First-class lathe, shaper and boring mill men accustomed to accurate work, for day and night shift; state age, experience and wages expected; no labor trouble; increasing force. The Heisler Company, St. Marys, Ohio.

Toolmaker Wanted—Specialist in making form tools and cutters as used in the line of watch case manufacturing; must be familiar with the use and heat-treatment of high-speed steel; wages $3.50 per day to start with. Address H. Detmering, Supt., The Dueber Watch Case Mfg. Co., Canton, O.

Superintendent; progressive manufacturer, having foundry, pattern and machine shops employing 500 men, needs a thoroughly experienced and systematic superintendent; machine shop and foundry experience essential; give full details, past and present record, naming employers; communications strictly confidential; only men with a record need apply. Box 688, AMERICAN MACHINIST.

Wanted — First-class machinists, lathe, planer, brass molders, drill press, screw machine boring and milling machine operators, die sinkers and patternmakers who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Building, Cleveland, O.

PENNSYLVANIA

Wanted—Good automobile and tool draftsmen; also tracers. Apply Chief Draftsman, Matheson Motor Car Company, Wilkes-Barre, Penn.

Wanted—Young man as steam engine salesman; only replies giving full details of past experience, training and remuneration will receive consideration; all replies confidential. Box 783, AMERICAN MACHINIST.

Wanted—A good live agent in every shop or factory in the U. S. to sell one of the best known preparations for removing grease and grime from the hands without injury to the

# The Rice Two-cycle Double-acting Gas Engine

## Something New for Automobiles and Motor Boats. A Gas Engine That Can Be Started and Reversed as Easily as a Steam Engine

BY HOWARD GREENE

The history of the development of mechanical engineering shows that, figuratively speaking, science has climbed steadily to higher and higher levels, not going up in a straight line, nor yet running around in a flat circle, but in a great spiral, each sweep passing over the same points but each time on a higher plane. How often we find that at the present day some mechanical problem is attacked and solved and put into harness, while a decade or so ago the same problem baffled the best efforts and had to be abandoned. Engineering science, in making its sweeping circles, inevitably passes over the same ground and the same problems are encountered; but they are attacked from a higher level of knowledge, and that which was before impossible becomes comparatively easy of solution. It is not often now that anything really new is evolved; rather, existing ideas and forms are put together in new combinations which are capable of producing entirely new results, which, after all, is the thing to be sought.

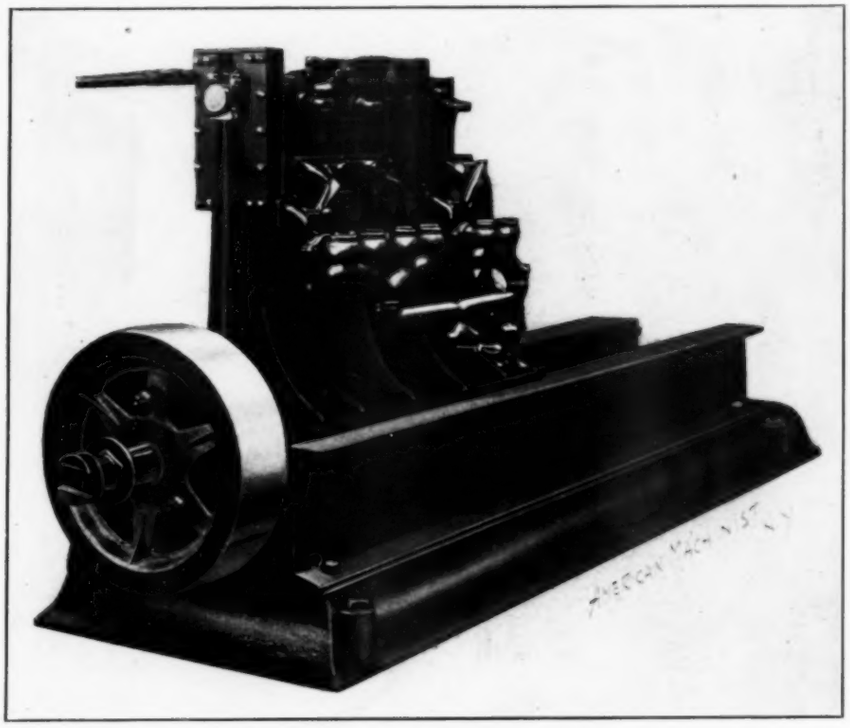


FIG. 1. RICE TWO-STROKE DOUBLE-ACTING ENGINE

These ideas are forcibly brought home by an inspection of a new explosion motor that has just finished its experimental stage and is in process of preparation for the market. The motor is of the two-cycle type and is double-acting; like a steam engine of the ordinary type each piston receives and imparts to the crank shaft two impulses each revolution, and there are no idle strokes. As in two-cycle motors of the familiar kind, there is one piston and one connecting rod for each cylinder, and one crank shaft common to all cylinders. There is no crank case; the crank shaft with its bearings, the connecting rods and wristpins being outside and as easy of access as similar parts of a steam engine. In addition to these parts there is a piston rod for each piston; this rod and the stuffing box through which it passes are not subjected to the heat or the pressure of burning gases, but are kept cool by the incoming charges and never reach the temperature or work under the pressure to which similar parts in a steam engine are subjected. With three cylinders of this type, which was found to be a very desirable number, no flywheel is necessary nor is one used. Not only is the engine self-starting, but it can be started cold under four-fifths of its full load. It can be started with equal facility in either direction, and can be reversed under full load as positively and at least as easily as a steam engine. Starting in either direction and reversing are accomplished solely by the manipulation of the ignition lever, which acts upon the starting and reversing mechanism (to be described hereafter), as well as upon the ignition timer, the two working in complete harmony so that the movement that is right for one is right for the other.

The motor (see Fig. 1, showing an early model) is the invention of John V. Rice, Jr., of Bordentown, N. J., who has been for many years identified with the manufacture of marine gas engines, and it will be manufactured and marketed by the Rice Gas Engine Company, 71 Broadway, New York City.

### Salient Features of Construction

The salient features of construction and the principle upon which the engine operates are shown diagrammatically in Fig. 2. A cylinder, which is closed at both ends where the compression chambers are located, as usual, is not of one diameter throughout, but has a central section of greater diameter than the end sections; and the increased diameter is all on one side; that is, eccentric with the bore. The piston is made with a corresponding eccentrically enlarged middle section. The relative dimensions of the different parts of the cylinder and piston are such that at the end of the stroke, either upward or downward, there is a space between the enlarged part of the piston and the end of the chamber in which it works.

The enlarged part of the cylinder, with the correspondingly enlarged piston, constitutes a pump whose functions are to draw in the combustible gas and compress it sufficiently to force it through the transfer passages and ports when opened by the passage of the piston. The pumping piston also serves the very important purpose of carrying the piston rod, which passes upward through a stuffing box. The upper end of the piston rod carries a crosshead, Fig. 1, which works in guides, and the crosshead carries a wristpin for the upper end of the long connecting rod.

The piston rod, working in the cool pumping chamber, never becomes very warm, and there is no difficulty whatever in keeping the stuffing box tight because the pressure in the pump chamber is, of course, low. It will be seen at once that the most serious fault of the crank-case pump of the ordinary two-cycle engine, namely, gradual loss of pressure and of fuel through wear of the main bearings and consequent decreased power and efficiency of the whole engine, is absent, and there is nothing to prevent the pump

from sending full charges to the cylinders at all times. Moreover, the ratio of primary compression and volume can be made anything the designer pleases, there being no such limitations as those imposed by the necessity for giving crank clearance.

The crank shaft is carried in bearings under the cylinders, so located that they are easily reached. In fact, this may be said of all the bearings in the engine—crank shaft, crank pins, wristpins and crosshead guides. All are where they can be watched and attended to, and can be adjusted and, if necessary, lubricated without the trouble that attends getting at these parts in the ordinary two-cycle or four-cycle gas engine.

The distribution of the incoming combustible gas and the egress of the exhaust are worked out in practically the same way as in the usual type of two-cycle two-port motor, and may be understood easily if the ends of the cylinders are considered as two separate cylinders and each end of the pump chamber as a separate crank case. The upper end of the cylinder is served by the lower part of the pump chamber, and *vice versa*. Therefore, there is a transfer passage leading from below the pumping piston to a port in the wall of the upper working cylinder, and a passage from above the pumping piston to a port in the wall of the lower working cylinder. The exhaust ports open opposite the intake ports, as usual. The intake from the carbureter is through a manifold with a branch opening into each transfer passage, there being a check valve in the branch, close to the transfer passage, opening inward.

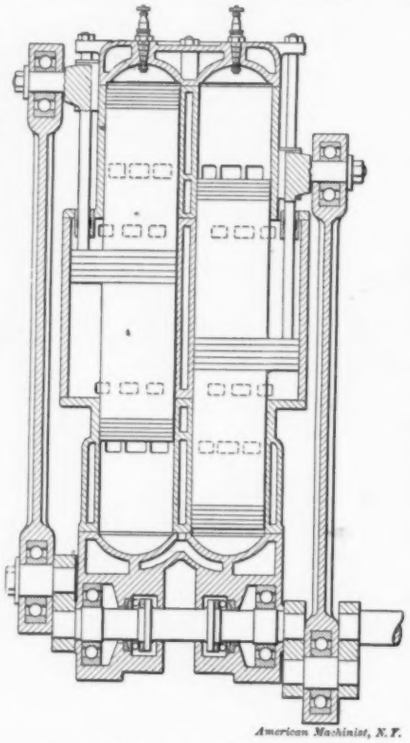
### Principle of Operation

Taking the upper end of the cylinder for explanatory purposes, the operation of the engine is as follows: Suppose the piston to be at its lowest point and commencing the upward stroke; the pumping piston as it ascends draws a charge into the lower part of the pump chamber, the check valve in the manifold being opened by atmospheric pressure. At the end of the upward stroke the check valve closes and the gas in the pump chamber, having no exit, is compressed by the pumping piston on its downward stroke. Just before the limit of downward movement is reached the working piston uncovers, first, the exhaust port, permitting the burned gas from the previous charge to escape, and immediately afterward the port into which the transfer passage from the lower part of the pump chamber opens, permitting the fresh compressed gas to rush into the working cylinder. The piston immediately reascends, closing both ports and compressing the gas into the combustion chamber where it is ignited in the usual way. And so on.

Meanwhile the same cycle is being carried out in the opposite or lower end of the cylinder, with this difference, that while the upper end of the working piston is compressing a charge preparatory to ignition, the lower end is receiving an upward impulse. While the lower end is compressing, the upper end, in turn, is expanding its charge. It is exactly the same effect, so far as torque is concerned, as if there were two cylinders of the ordinary two-cycle type working on a two-throw crank shaft.

### Details of Construction

In the details of construction a number of interesting points are found. Perhaps the first idea to occur upon examining the motor for the first time is that the offset pumping piston and the piston rod at one side transmitting to the connecting rod the full energy of the explosions would produce an abnormal tilting tendency and great lateral pressure on the piston as a whole, and cause loss of power and rapid wear of piston and cylinder walls. As a matter of fact, the lateral pressure of the piston on the cylinder walls is very much less than in engines of the trunk-piston type, in which the pressure is, generally speaking, in the neighborhood of 18 pounds per square inch, while in the Rice engine the pressure is but 4 pounds to the square inch. In order to avoid the tilting tendency the piston is made in three parts, namely, the two working ends and the middle or pumping piston. The latter carries on heavy stems two balls which enter sockets, one in each working piston head, and are held in place by suitable followers. These ball-and-socket joints are so located that the lateral pressure is equally distributed over the piston walls, and there is no tilting action.



*American Machinist, N.Y.*

FIG. 2. DIAGRAM OF RICE TWO-STROKE DOUBLE-ACTING ENGINE

### Pistons

Each piston head is fitted with three scarf-jointed rings, and the pumping piston with two rings (see Fig. 3). Two external rings are let into grooves in the cylinder walls, one immediately above and the other immediately below the pumping chamber, to insure against leakage from one part of the cylinder to another.

### Cylinders

The cylinder proper is made in three parts. The lower part includes the combustion head and lower working cylinder, and is cast integral with the base which supports the engine and with the upper halves of the brackets in which the annular ball bearings for the crank shaft are carried. The second section consists of the pumping chamber and the upper working cylinder, and the third section is the combustion head of the upper working cylinder. The sections are bolted together through flanges with ground joints. This method of construction makes the taking down and assembling of the engine a matter of little difficulty, and any particular part can be reached in a short time and with a minimum of trouble.

A dual-cylinder and a single-cylinder unit are made, so that engines with any number of cylinders, from one upward, can be built. In the last engine built by Mr. Rice, Fig. 4, for testing purposes, three cylinders were used, a dual and a single unit together working on a three-throw crank shaft, Fig. 5, with cranks set 120 degrees apart. This engine ran with perfect steadiness and a remarkable absence of vibration and without a flywheel, and not only ran, but reversed and started, either on the spark or under the automatic air-starting system, with all the reliability of a steam engine.

It is noteworthy that the weight per brake-horsepower was but 8 pounds, notwithstanding the fact that all the parts were heavy and substantial—a little too much so in many details—and that no attempt was made at lightness. The absence of flywheel and crank case is, of course, the chief factor in this, and it is apparent that with reasonably high compression—the engine referred to had low compression—with care in the use of metal so that there will be a minimum of unnecessary stock, and with the judicious use of aluminum alloys, a motor can be constructed that will be extremely light for its developed energy without being in the least degree lacking in strength and stability.

Water jackets surround the working cylinders throughout their length, but no jacket is used or required for the pumping chamber. Though there have been some severe tests, there has been no difficulty in adequately cooling the engine, using, in one test, an automobile radiator designed for a four-cycle, four-cylinder motor of the same horsepower rating.

The circulation of cool gas around the inner ends of the working piston heads doubtless has a good deal to do with the absence of overheating. No trouble has been experienced from back firing.

### Air Starting and Reversing System

The compressed-air starting and reversing system previously referred to is not only effective and reliable in actual service, but is simple and not likely to get out of order. In common with many other gas engines an air pump and an air-storage reservoir are used in order to store up the energy necessary to turn over the engine for starting; but it is in the method of handling the air after leaving the reservoir that the Rice system is particularly noteworthy, and a description of the mechanism and its operation will be of interest.

At the end of the motor opposite the coupling or clutch end, as the case may be, is mounted the timer, as already described, with its shaft parallel to and above the crank shaft and gear driven at the same speed as the crank shaft. The distinctive feature of the system, the air distributer, is mounted with its shaft coupled direct to and in the same axis as the timer shaft which drives it. Air is led from the reservoir to the distributer through a pipe which is divided into two branches, the branches being carried to the air distributer past the timer, a branch passing on either side

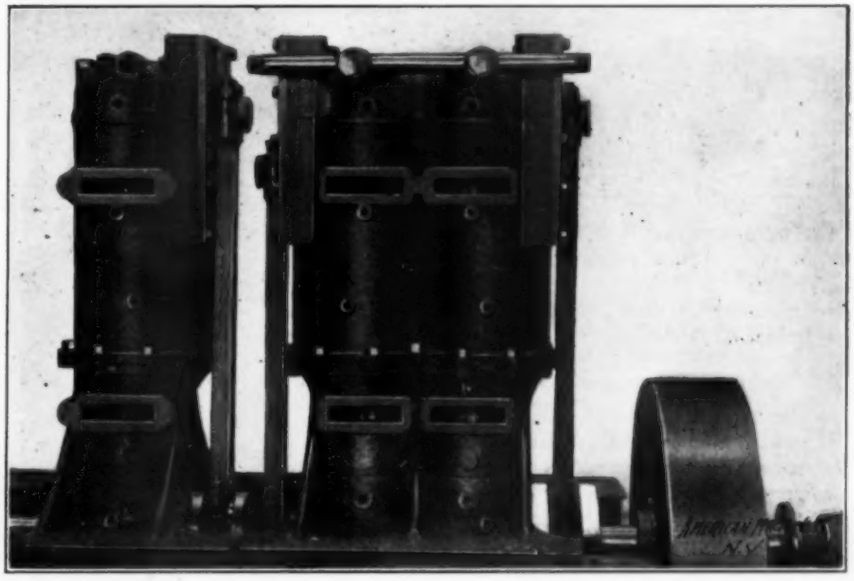


FIG. 4. A RICE GAS ENGINE SHOWING A DUAL AND SINGLE-CYLINDER UNIT

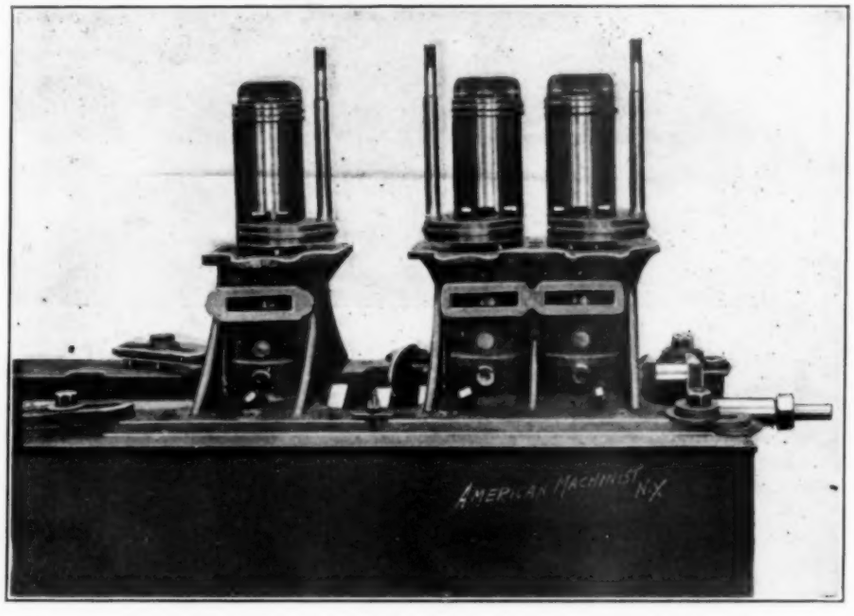



FIG. 3. PISTONS OF RICE GAS ENGINE

of the timer at equal distances from it. One branch is tapped into the forward side of the air distributer, furnishing the supply for moving the engine forward, and the other enters at the rear side, or side nearest the engine, and delivers air for starting in the reverse direction. From three equidistant points on the circumference of the air distributer pipes are led off, one to the lower end of each cylinder.

The supply of air to the distributer from the reservoir is controlled by two valves, one in each branch pipe, located directly opposite the timer. These valves are arranged to be actuated by two arms, one for each valve, attached to and rocking with the timer. When the timer is rocked one arm is, of course, elevated and the other depressed. The latter comes in contact with a small pin projecting upward from the valve and opening it when pressed down. It will be seen, therefore, that when the timer is rocked as far as it will go in one direction the arm on that side will depress the corresponding valve pin, open the valve and admit air under pressure to the go-ahead or the go-astern side of the air distributer, as the case may be; while throwing the timer lever in the opposite direction will have the effect of opening the valve admitting air to the opposite side of the distributer. The valves are automatically closed by springs, so that the air is shut off as soon as the pressure of the arm is removed from the valve pin.

As the reader will already have figured out, the timer, air distributer and admission valves are so arranged with relation to each other that when the timer is rocked to give a retarded spark, say, for starting forward, the valve admitting air to the go-ahead side of the air distributer is caused to open and the engine is started. As air is admitted only to the lower ends of the cylinders, the upper ends are left to pick up the load. As soon as they are working the timer is rocked so as to advance the spark slightly (the usual procedure when the engine gets under way), and this permits the air valve to close, whereupon the lower ends of the cylinders take up their share of the work.

As there are three explosions during each revolution in the upper ends of the cylinders when the lower ends are under air pressure, it is a very quick matter to start. In actual practice two or three revolutions of the crank shaft are ample when starting cold. With gas in the cylinders the air is unnecessary, as the spark alone will start the engine every time. The automatic starting system involves no extra levers; the timer control is carried on the steering wheel of the automobile or motor boat, as the case may be, in the usual way, and the engine started, regulated and reversed by simple movements of the ignition-control lever.

### Reversing Can Be Accomplished without Air System

In reversing the engine while in motion

the air system is not absolutely necessary, as the reverse can be accomplished by cutting off the ignition until the engine slows down a little and then switching it in after advancing the spark excessively. By using air, however, the element of uncertainty is entirely removed, and the operation of reversing is as positive as with a steam engine. Moreover, the cushioning effect of the air greatly reduces the danger of breaking the crank shaft when reversing suddenly at full speed, as in an emergency.

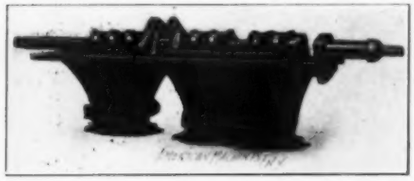


FIG. 5. CRANKSHAFT AND BEARINGS OF RICE GAS ENGINE

### Construction of Air Distributer

The construction of the air distributer is somewhat analogous to that of a spark distributer, it having two rotating valves, corresponding with the rotor of the ignition distributer, and ports corresponding with the electrical contact points. The valve rotates and openings in it register successively with and permit air to pass through ports opening to the pipes leading to the different cylinders. The port in one valve has a slight lead on the forward side, and the port in the other valve has a lead on the reverse side.

The valve rotates at the same rate as the crank shaft, and its operation is as follows: Suppose it is desired to start the engine ahead, and the lever is manipulated to open the forward-motion valve. This admits air to the valve chamber on the forward-motion side. As there are three cylinders, each capable of imparting an impulse to the crank shaft for nearly half a revolution, it is clear that the impulses will overlap somewhat, and that there will always be one piston in position to transmit an impulse to the crank shaft in the proper direction, no matter in what position the engine may stop. There is no possibility of being stuck on a dead center, because if one crank is on the center the one preceding it has still one-sixth of its revolution to pass through, and it will be the one to receive the impulse, the one on the center, however, taking up the work before its predecessor leaves off.

The air then passes to the cylinder and gives the piston the impulse. The air is permitted to pass to this cylinder until the stroke is nearly completed; but before the stroke is finished the valve has already opened up the port admitting air to the next cylinder, and so on. When the reverse supply valve is opened the other rotary valve comes into action in exactly the same way, except that the slot is cut so as to admit air only to those pistons which are in position to give the crank shaft motion in the reverse direction.

### Performance of an Experimental Engine

One of these engines, Fig. 6, fitted with the air-starting system, was used for an entire season in a fast launch, and its performance was exceedingly interesting. There was no flywheel, no clutch, no mechanical reversing gear or reversible propeller. A solid shaft, carrying a solid propeller, was coupled direct to the engine shaft. The engine was started at the beginning of the season by cranking in the usual way. The tank once filled with air, however, the engine was thereafter started pneumatically and throughout the season it was not necessary to resort to cranking—in fact, there was no crank in the boat at any time after the first start.

On one occasion the ability of the motor to reverse under full load was forcibly demonstrated. For the sake of making a test the engine was reversed while driving the boat ahead at its full speed of 19½ miles an hour. The motor responded instantly—so promptly and energetically in fact, that the man aft of the engine, though warned and anticipating a shock, was thrown violently forward and gashed his head on one of the cylinder heads. This was the only damage done. The reversing device proved absolutely reliable under all conditions, never once refusing to work promptly. The same may be said of the starting feature. Even after being idle for four weeks the engine started instantly on the opening of the supply cock at the tank and the throwing of the ignition lever.

Even when the engine is running at a very moderate speed the extreme rapidity of the exhausts produces a curious illusion of enormous speed. This will be readily understood when it is considered that the effect is the same, speed for speed, as that produced by a two-cycle engine having six single-acting cylinders, or a four-cycle engine having 12 cylinders. What is of more importance, however, is that the same ratio holds good with regard to constancy of torque. Six impulses are imparted to the crank shaft during a single revolution, each impulse extending over a little less than half a revolution; there are always three charges expanding simultaneously. At the beginning of the stroke of any piston, there will be one charge just ignited and commencing to exert its full power, one charge that has pushed its piston through one-third of the stroke, one charge two-thirds expanded and one piston at the end of its stroke with intake and exhaust ports uncovered. Such a motor is naturally far more flexible than any motor built heretofore with a manageable number of cylinders. The speeds at which the Rice motors have been run vary from 150 to 2500 revolutions per minute.

The Rice engine can be run in any position, from vertical to inverted, without

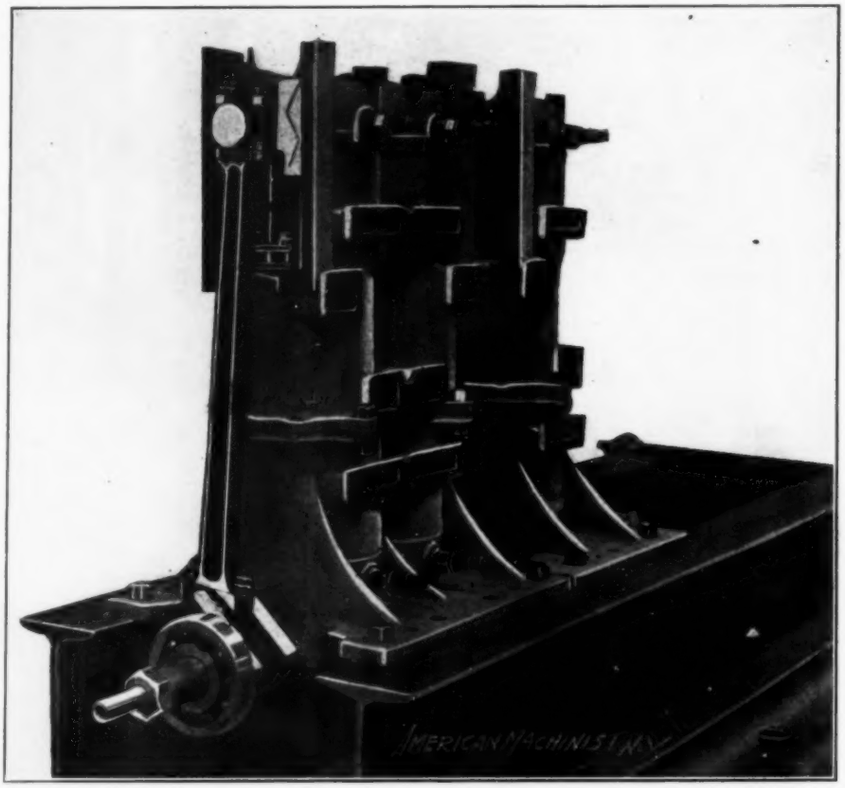


FIG. 6. ANOTHER VIEW OF THE RICE GAS ENGINE

detriment to its performance. In view of this fact, it would be entirely practicable to construct an engine of very great power in a small compass by arranging cylinders in a horizontal position on either side of a crank shaft. An engine with, say, four cylinders on each side of a shaft would do the work of an ordinary two-cycle engine of the same bore and stroke having 16 cylinders (which would, of course, be impracticable with a single shaft), or a four-cycle engine with 32 cylinders.

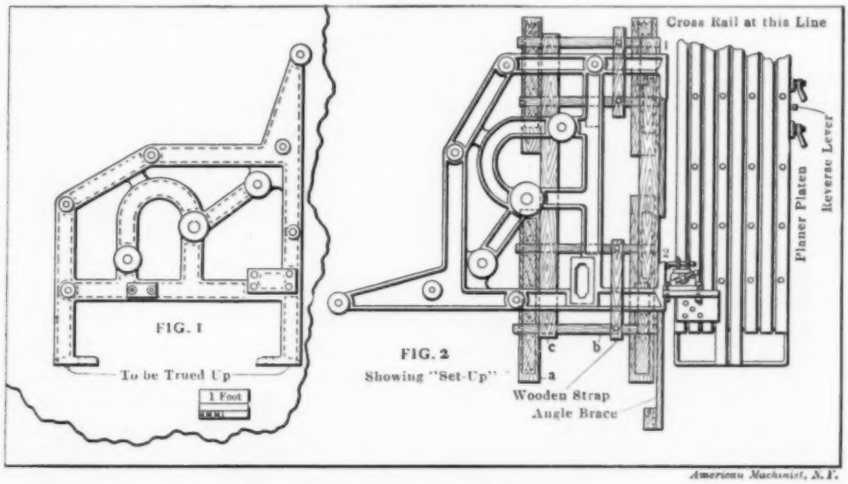
## A Planer Kink

By J. B. Chipman

We had worried along with the big Pond planer until we caught up with the heavy work, and then we had to take the feed friction off, for the purpose of fitting in a new bushing. Fig. 1 shows a side frame, part of an attachment that we were trying on a new press. This side frame is quite large enough to require the big planer to machine it—or, at least, we thought so. Now, this job had been "put through," but in some way it must have become cocked a little, for, in assembling, if set plumb, a crack would show about one thirty-second of an inch wide, on the outside, between the "foot bearings" and their seatings on the lower frame. This side frame, therefore, had to be trued up, and that "right away."

The Pond was out of service for the present, so the job had to be done on a small planer, as shown. The job was set up on the floor on the back or left-hand side of the planer. The platen carried the tool in a 20-inch shaper head bolted to an angle plate. Its effect was, of course, similar to that of a shaper ram. First, the four pieces of timber marked *a* were spiked to the floor, because the rig without them would be too low. They were placed approximately correct. Then four wooden trestles were spiked to the blocks *a*. Running parallel to the platen, the string pieces *c* were then spiked to the trestles *b*. On this rig the side frame was placed, and clamped lightly by means of the wooden straps shown, one five-eighths hole being put through each trestle to receive the bolts which were set head down as usual. The job was leveled up by placing a straight-edge across the already planed bosses and placing a level on the straight-edge. We were to work to these bosses. When the job was set near enough to the planer to just clear the platen (nearer than shown in the drawing) and leveled up, the clamps were finally tightened. The two pieces of inch and a quarter planking shown on the drawing as "angle braces" were set in place and spiked to a block secured to the floor and also spiked to the string piece *c*. The shaper head was of the old style set to angles with two bolts in elongated slots, and to set this properly caused the angle plate to overhang; so a rectangular piece had to be cut out of the angle plate both base and face to clear the work. The angle plate was then bolted to the platen and the shaper head to the angle plate. The tool was set to travel plumb by raising the tool as far as it would go and then lowering it along the blade of a square. As the work is shown the heaviest cut is on the upper side, so, as the old man said, "the tool won't crowd off." I don't take much stock in this theory myself. Three cuts were taken. Only one setting was required, the stroke dogs only being shifted; when a cut is run over one foot bearing the same depth should be planed off the other also before the tool is set in for another cut. This everyone knows. We had to feed the tool down by hand, of course. Maybe this idea of carrying the tool on the platen may serve someone in ways other than the one described here—I hope so.

[We have seen the rail and head removed and bolted to the end of the planer table, thus converting the planer into a shaper.—Ed.]




A PLANER USED AS A SHAPER

## The Smallest Machine Shop Power Plant

Editorial Correspondence

One of the smallest power plants that it has been my privilege to see running a machine shop is that shown in Fig. 1. It drives the machinery in the machine shop, pattern shop and foundry of J. C. Wilson & Co., Glenora, Ont., who are the

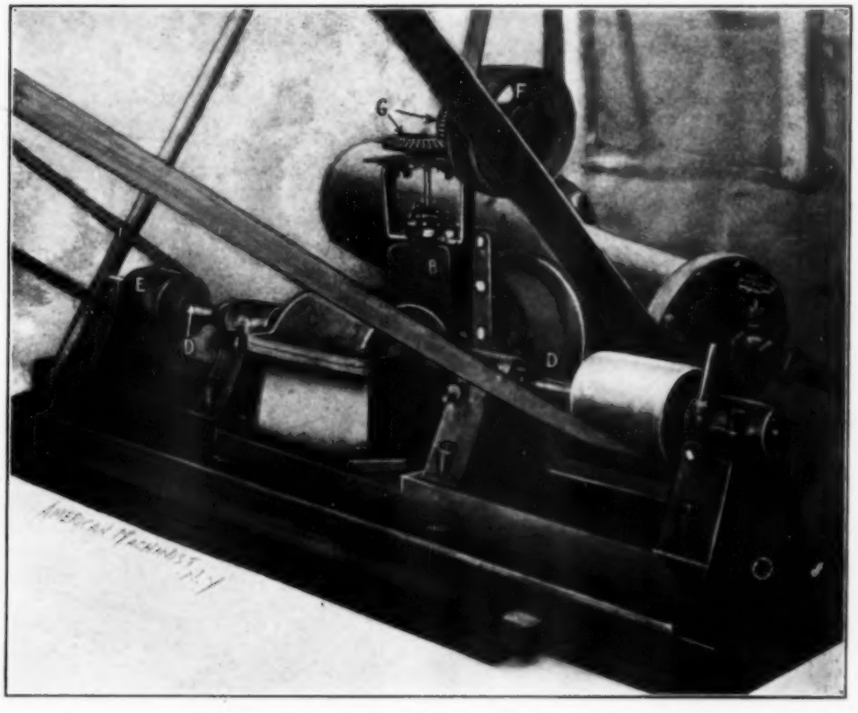



FIG. 1. TURBINE WATER WHEEL POWER PLANT THAT RUNS MACHINE SHOP

builders of the same turbine water wheel here shown, as well as conducting a general business as mechanical engineers, iron and brass founders. The water comes in through the pipe *A*, and the gates located inside the case at *B* and passes through the water wheel inside the case *C*. The shaft *D* is made of tool steel 1⅛ inches in diameter, and connects the turbine water wheels to the pulleys *E E*. It runs at a speed of 3200 revolutions per minute, which is reduced to 400 revolutions on the line shaft by means of a larger pulley, and develops 28 horsepower.

The water wheel itself is a double one that is 4¼ inches in diameter, as shown in Fig. 2. The gate box is supplied with a partition in the center of the wheel so that either side can be run independently, or both gates left open, and water supplied to the whole wheel. This latter is the usual method, as the only difference is in the amount of water used, and consequently the amount of power developed.

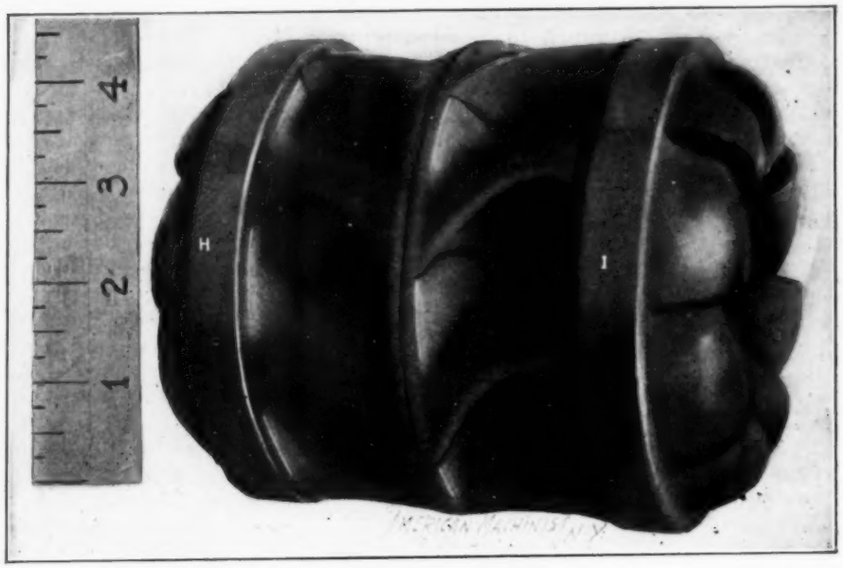



FIG. 2. PATTERN FOR WATER-WHEEL CASTING USED IN POWER PLANT

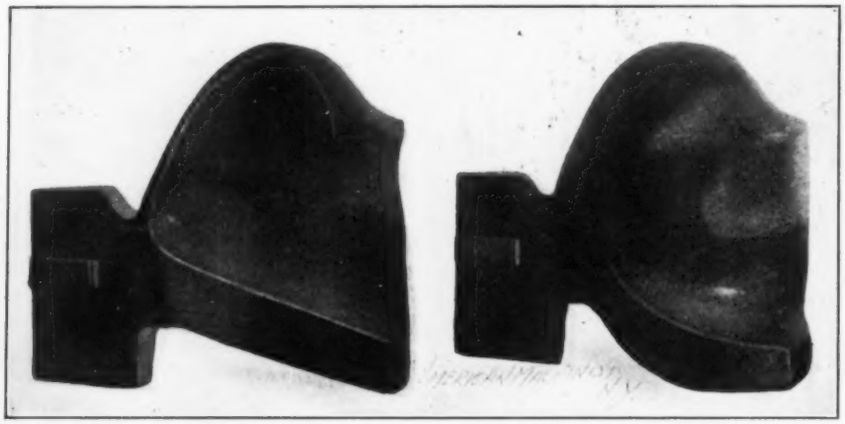


FIG. 3. FRONT AND BACK VIEW OF A BUCKET SECTION OF PATTERN

In the machine shop it runs one 16-inch planer, one 32-inch planer, one ordinary drill press, one radial drill and seven lathes varying in size from 12 inches to 13 feet. In the pattern shop it runs one band saw, one circular or buzz saw, one surface planer and two wood lathes. In the foundry it runs the blower or fan that supplies the blast for the cupola.

The power plant, Fig. 1, is located in the basement, and the pulley *F* and bevel gears *G* are connected to the gate so it can be opened and closed from the floor above, which is the machine shop. The water to run this wheel with has a head of 175 feet, and is obtained from a small lake that is so near directly above the shop that the pipe through which the water flows is only given a slight incline from the vertical position.

This lake is one of the freaks of nature that has attracted several scientific men and numerous investigations have been made. It is called Lake on the Mountain, because of its being situated on the highest point of land around there, which rises almost abruptly out of the Bay of Quinte, which is an arm of Lake Ontario. Its bank is only about 200 feet back from the bay, its surface is 180 feet above the surface of the bay, and it has an area of about one square mile. There is no visible source of supply, yet there is a never-failing stream flowing from it continually.

Its waters are not stagnant, but they are so clear that the bottom can easily be seen at a depth of 25 or 30 feet, and the water is quite cool. It is one of those bodies frequently met with, of which the natives say "it has no bottom." Soundings which have been taken, however, show several places which appear to be holes, through which, doubtless, springs or subterranean streams

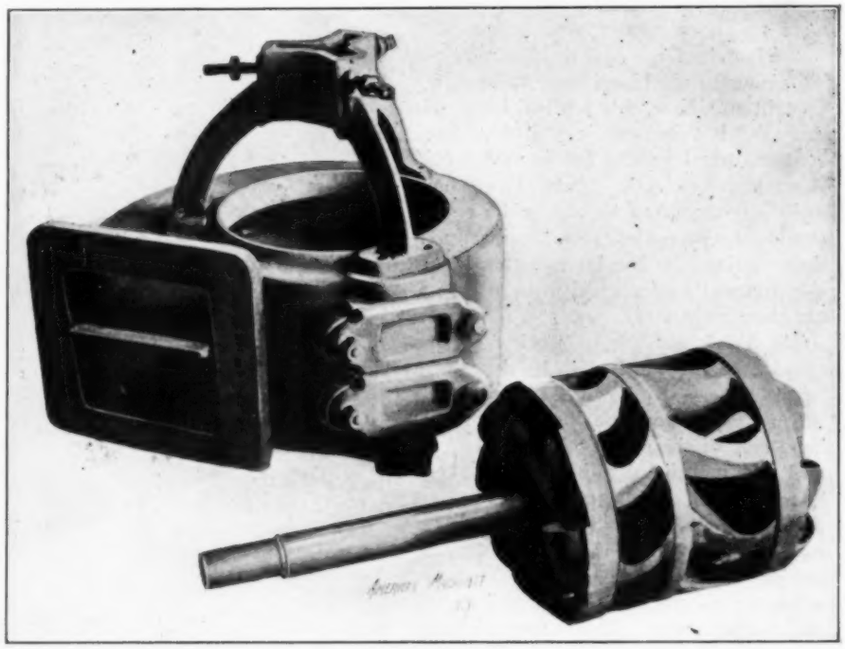


FIG. 4. CASE AND DOUBLE TURBINE WHEEL ON SHAFT READY TO ASSEMBLE

flow. One of these holes has shown a depth of 200 feet, while close to it the lead showed but 150 or 160 feet. The temperature of the water, in some places, when taken in August, showed 42 degrees Fahrenheit, which is some 6 or 8 degrees colder than Lake Superior, which is the coldest of the great lakes.

From the banks of the lake a beautiful view is obtained of the bay of Quinte, and the surrounding country. The bay with its rocky slope rising abruptly from the water's edge, or the sloping shores with their green sward, fields of grain or timber land, and its crooked shores with numerous bays, points of land and islands make a sight worth traveling many miles to see. Some 15 miles to the west on Lake Ontario, can be seen the Sand Banks, which is another curiosity consisting of pure white sands piled some 100 or more feet high and extending for about five miles along the beach. The sand drifts like the wind-driven snow, and by digging into its depths ice can be found in the middle of summer. But as summer vacations are over, and this is not an outing paper, I will have to get back to the mechanical end.

This power plant is not an experiment, as it was installed in 1892 and has been running continuously since that time. The pattern making and molding of the water wheels is quite a nice job, and Fig. 2

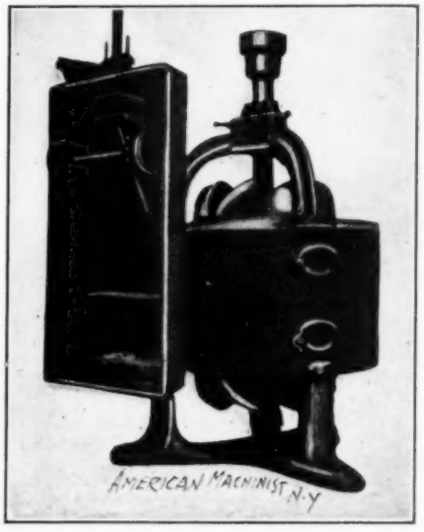



FIG. 5. DOUBLE VERTICAL TURBINE WHEEL

shows the metal pattern that is used when molding it. In Fig. 3 will be seen a front and back view of the sections that form the wheel. Eight of these go together to form a single wheel, and 16 to form the double one shown in Fig. 2. When they are placed together the rings *H I* are slipped over them to hold the pattern intact while it is being molded, which is done in a specially constructed flask.

In Fig. 4 will be seen the water wheel keyed to its shaft, and the case in which it goes, as they are ready to assemble. They are built in either the vertical or horizontal style, the only difference being in the case. In Fig. 5 is shown a vertical water wheel that is completed with the exception of the cover over the gate, this being left off purposely to show the operation of the gate.

E. F. L.

## Gear Wheel Cutting Rig

BY C. PETITJEAN

The accompanying sketches and description are of a special gear-wheel cutter for cutting a wheel and pinion which are used in the magneto of the call box of a telephone set. The concern I was with used a few thousand pair of these wheels per year, and to keep pace with the assembling department, also to cheapen the cost of production, this rig was designed and proved to be one of the most efficient tools in the works. A youth, when he became used to the machine, could cut the large

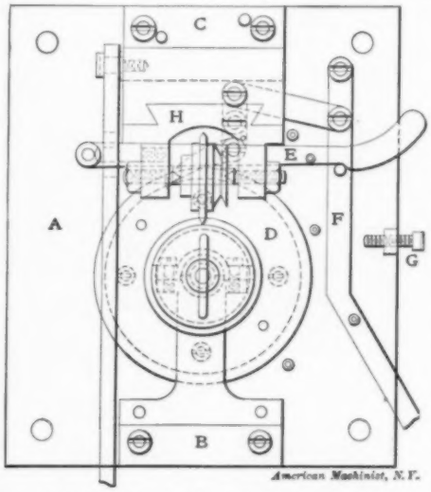



FIG. 1. PLAN OF GEAR-CUTTING RIG

wheels (140 teeth in each) at the rate of 14 per hour, and the small pinions (35 teeth in each) at the rate of 30 per hour. As the wheels were 5/16 inch wide it was pretty good work.

If necessary the output could have been almost doubled by cutting two wheels at a time by placing them back to back, but it meant too long a stroke of the lever as the slide would have to move twice the distance.

The cutters were left dead hard, allowing the spindle to turn at a very high speed and leave the teeth with a highly finished surface. This was necessary as they had to run very silently because the box acted as a sounder and magnified the noise, so that though they seemed very noisy, when the box was opened you could hardly hear them run. This trouble was avoided later on by using rawhide and fiber pinions.

In Fig. 1, *A* is a cast-iron base plate on which are fitted two castings *B* and *C*; one to carry the wheel, spindle and index wheels, the other fitted with a slide which carries the cutter driven by a small overhead countershaft. On the spindle which carries the wheel to be cut is fitted an index wheel and to this is fixed a ratchet wheel with the same number of divisions as the large wheel. This ratchet wheel is rotated by a pawl which, in the case of the large wheel, is moved one notch at a time, but it can be adjusted to feed four notches at a time for the small pinion.

The indexing is regulated with the lever

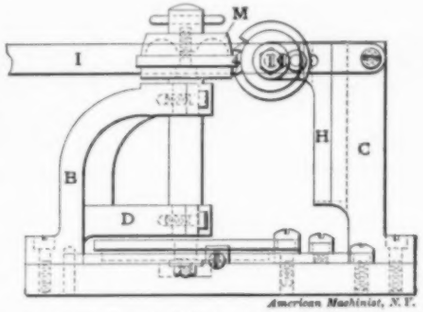



FIG. 2. ELEVATION OF GEAR-CUTTING RIG

*F*, which has a pin fitted so that it rides on the cam on the end of the lever. In doing this it brings the locating stop out of the index wheel; then by continuing the movement of the lever *F* the necessary movement is given to the pawl so as to move the spindle around one tooth, the lever being brought against the stop screw *g*, thus bringing it in the right position for the index lever to locate it. The lever *F* is brought back by a spiral or helical spring not shown in the sketch.

The bracket *C* is machined for the slide *H*, which carries the cutter spindle and is driven by a countershaft. The slide is worked by the lever *I*, Fig. 2, which is held in the left hand of the operator, the index lever being held in the right hand, so that the two levers are worked with hardly any time lost in the two operations. Springs were fitted on all the levers so as to bring them back into position.

The base was counterbored for the end of the spindle so as to bring the index wheels as near to the base plate as possible. The sketch shows the wheels in position. The dome *M* is used as a nut for clamping the wheel as near the outer edge as possible, as in the case of wheels with arms it was necessary to clamp them on the rim to keep them from chattering while being cut. A special adapter was made to cut the pinion, as the cutter would not clear the frame if the spindle was not lengthened. The ratchet wheel was fitted to the index wheel with four screws and two dowel pins.

Of the $368,000,000 worth of manufactures sent to Europe in 1908, $97,000,000 was copper, $55,000,000 mineral oil, $47,000,000 manufactures of iron and steel, $39,000,000 manufactures of wood, $17,000,000 naval stores, and $14,000,000 agricultural implements.

# Examples in Modern Grinding Practice

## Bearing Rollers, Guns, Special Shafts and Car Axles, Form Some of the Work Finished Accurately and Economically in Grinding Machines

BY H. DARBYSHIRE*

The columns of this journal have from time to time contained accounts of some interesting grinding jobs. I have myself been a contributor along this line occasionally and at times may have been too sparing in detail; certainly in many articles this fault has been only too evident, and is to be deplored, for in such cases the article fails in the purpose for which it was written, and has at times induced the publication of correspondence which displayed some little scepticism. In connection with the matter before me I propose to give detailed description of the methods employed in each particular case as far as is possible, together with results obtained; further than this I propose to submit revised methods of preparing or executing each particular job where it seems to me that still greater saving could be made. Given that this line is followed it should be apparent that if the same methods be employed, in the same or in similar cases, similar or still better results should be obtained. Some of these revised methods have been proposed to the parties most concerned who may or may not have adopted them, but apart from this the information may be of use to those of a less matured experience and I hope that its publication may be of service to myself and other readers of the AMERICAN MACHINIST. To achieve this end critical correspondence is invited and it may safely be hoped that if this line is followed some matter of a general educational value may be gathered. Most of the examples given have been ground by me in the course of my business as a demonstrator, and it is with pleasure I have to relate that the results obtained have been improved on by the operator left behind in many cases; other examples are those which have come under my notice in various parts of Europe, and my thanks are due to those who have both consented to this narration and given valuable assistance in relating particulars which did not meet the eye.

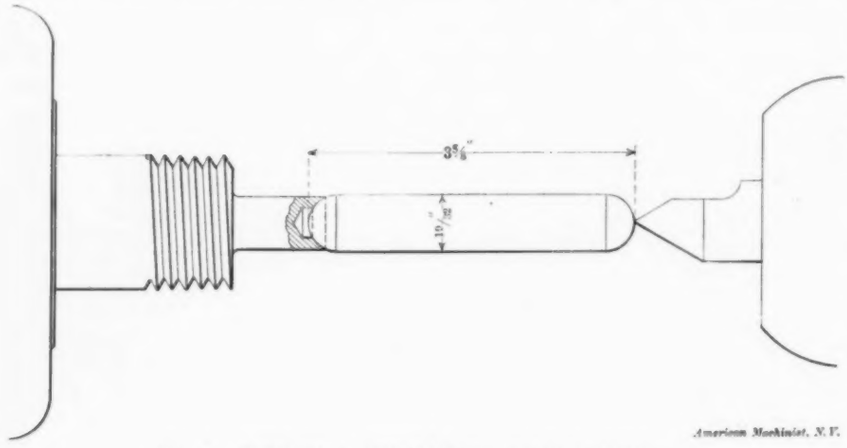



FIG. 1. GRINDING A SPHERICAL-END BEARING ROLLER

### GRINDING SPHERICAL-END ROLLERS

Some roller bearings were wanted in large quantities of a size and shape shown in Fig. 1. They were made from ⅝-inch bar stock in a Herbert turret lathe, one spherical end being formed by an end-rounding tool in the turret and the other by means of a form-cut-off tool held in the tool post. A chip was taken over the body leaving from 0.010 to 0.015 inch for removal by grinding, one end only being centered; they were then carbonized and allowed to cool slowly in a box of lime to give them something of an annealing process. After this they were reheated and plunged vertically in an acid bath to harden them. To grind them a No. 3 Brown & Sharpe universal machine was used with a few little innovations. It being considered that a faster table feed than was provided would be of some advantage a wood sheath was fitted to the cone pulley of the overhead work which increased the table feed about 80 per cent. The work was driven by means of a plug fitted in the center hole of the fast headstock, as shown in Fig. 1, the pressure of the center in the spring poppet being sufficient to prevent any slipping; with this method of driving it was not necessary to stop the work driver to place in position or remove the work. That is, the universal head ran continuously and the work could easily be removed or placed in the machine while the spindle was running. The rollers were first roughed down with the automatic feed to within 0.0015 to 0.0025 inch of finished size at the rate of 138 per hour. A Norton 46K wheel was used with 1-inch face and a cross-feed of six teeth, or 0.0015 inch was given at each end of the stroke. For finishing the same wheel was used, nicely trued up, one tooth feed being used, or 0.00025 inch at each end of the stroke and 125 per hour were finished to a limit of 0.000125 plus and minus. The same speeds of work, wheel and table were used throughout, the work revolving at 180 revolutions per minute, the wheel speed being 5500 feet per minute. The wheel lost in roughing out an average of 0.001 inch in diameter in roughing nine pieces, but in finishing it maintained its size for an average of 30 pieces. The gaging was done with an ordinary tolerance snap gage and after a few dozen had been ground it was found that applying the gage was merely a matter of form, that is to say, it was possible to guess pretty correctly when the work was to size by the density of the sparking

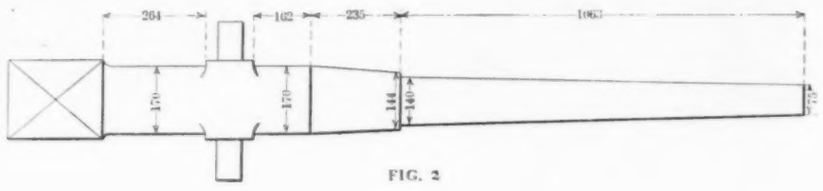



FIG. 2

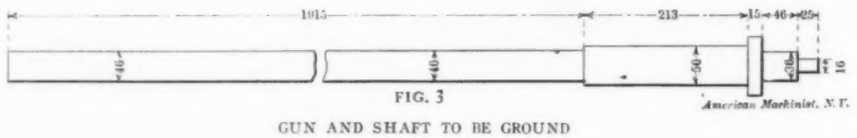



FIG. 3

GUN AND SHAFT TO BE GROUND

*European demonstrator, Norton Grinding Company.

from the wheel and the gage was only applied to about every 20th piece ground. That this judgment was effective may be gathered from the fact that only an average of 3 per 1000 had to be returned to the machine for a slight reduction.

### Handling Larger Stock

These roller bearings were made from 5/8-inch cast steel of a medium quality, and there being only 1/32 inch for removal, by turning and grinding, the bars had to be reeled very true. After a batch of some 4000 had gone through the stock of bar steel ran out and until it could be renewed it was resolved to use steel of the next size in stock, this being 11/16 inch in diameter. There now being ample material to remove it was not thought necessary to reel the stock and some hundreds were made from the raw bar. While all the rollers made from the smaller stock had gone through without trouble, about 20 per cent. of those made from the larger stock were distorted after hardening and would not clean up to size; an attempt to straighten some of these resulted in breakages in many cases, in other cases where the straightening had been successfully accomplished and the pieces had cleaned up to size, they were rejected at the inspection bench as being bent and this was some proof that the straightening process had been a waste of time. It was assumed that the larger steel being of exactly the same quality, the whole trouble was due to not first reeling the stock, and that during the annealing or hardening process it had changed its shape; however, the 5/8-inch bars weighed less and came cheaper and a fresh supply coming in the rollers were made as in the first instance and no further trouble was experienced.

It should be mentioned that an attempt was made to grind the bearings from the black stock; that is, without taking the chip over the body. This was found at that time to be no economy, the scale on the steel causing the wheel to fill up and become glazed; this occurred so frequently that the diamond had to be applied very often to dress the wheel and only 57 per hour could be ground. Later experience has proved that either pickling the pieces or using a grade or half-grade softer wheel would have overcome the trouble and might have given more profitable results.

### French Arsenal Work

Tenders were asked for by a French naval arsenal for a plain grinding machine to grind the gun and shaft shown in Figs. 2 and 3. The Norton Grinding Company tendered for this job along with two other well known firms, whom we will call A and B. The specification was that both gun and shaft were to have 1 mm. removed by grinding, to have good surface finish and to pass gages provided, these gages gave a tolerance of 0.02 mm. plus for the shaft and 0.25 mm. plus and minus for the gun. For grinding the gun, A guaranteed a time of 2 hours, B gave 2½ hours, and the Norton Grinding Company guaranteed to grind it complete in 45 minutes. For the shaft, A guaranteed a time of 1¾ hours, B gave 2¼ hours and the Norton Grinding Company 45 minutes. The Norton Grinding Company got the order on the strength of the shorter time but with some heavy penalties attached for nonfulfilment of the contract and the machine, an 18x96-inch electric driven self-contained, was delivered and set up. There were only two guns prepared for grinding, so that all experience of the job had to be gathered from grinding the first one; this occupied a time of 75 minutes but note was taken of the graduation marks of the swivel table when set for the tapers, as some precaution for the future against losing time in finding these tapers. One universal steady rest was fixed on the portion to the left of the trunnions, another near the muzzle and a third where the two tapers meet.

The gun was first rough ground on either side of the trunnions, then the table was swung over and the steep taper roughed and after this the long taper was roughed, the table first being readjusted to suit; the amount left for finishing was about 0.05 mm. The wheel was now trued up nicely and the long taper finished to gage, next the short taper, then the table was set at zero and the parallel portion finished, the total time being 41 minutes.

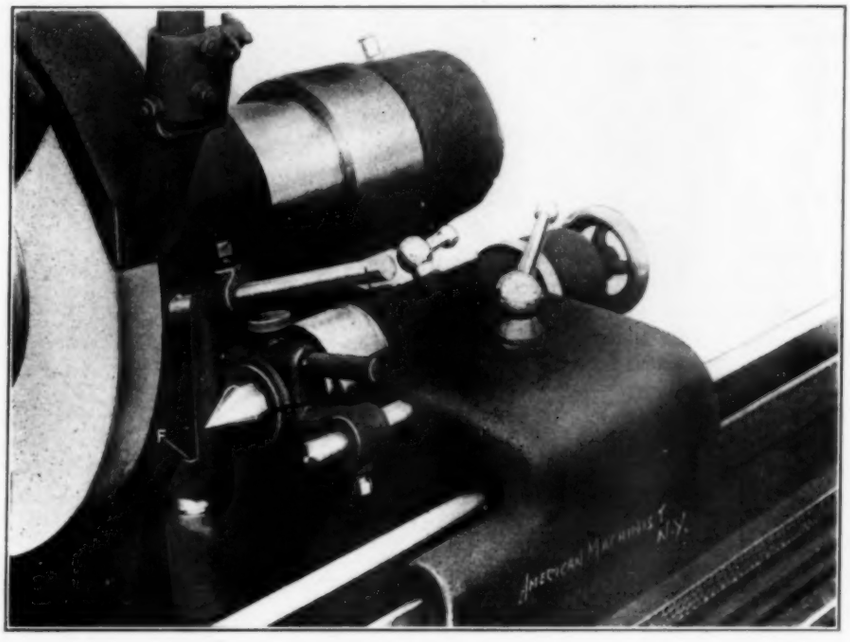



FIG. 4. RADIAL TRUING DEVICE FOR NORTON GRINDER

### Grinding Shafts

There were four shafts to be ground and after grinding two to get some practice it was decided to have the time test on the third. The first shaft had occupied 95 minutes and the second 62 minutes, so that there was some 17 minutes to pull up. Five universal steady rests were used equally distributed along the shaft and the larger diameter was first roughed down to within 0.05 mm. of finished size; the same was done with the longer portion and after truing up the wheel this same part was finished to gage and the shaft turned end for end in the machine; the two shorter diameters were then finished by forming cuts, also the collar, and the larger diameter last, the whole shaft being completed in 40 minutes. A 24L Norton alundum 2-inch face wheel was used in both cases running at 6000 feet per minute. The side feed or travel of the work in both examples was 5 feet per minute, this being the fastest feed on this particular machine. For the shaft (machine steel) a work speed of some 30 feet per minute was given but for the gun 55 feet was given, as it was of somewhat harder material and really required a softer wheel.

### A Wire Wound Gun

Using about the same speeds and with a similar wheel another type of built-up wire-wound gun was ground on a Norton 18x168-inch machine which gave very satisfactory results; the A or inner tube was ground in 2½ hours, it being necessary to use 21 separate gages for variations in diameter. This job was of interest from the fact that the diameter had to vary every five inches from 0.001 to 0.002 inch, this to correspond with the bore of the shell to be shrunk on. The wire winding was afterward ground, and here it should be said that grinding was found to be an immense advantage over turning in this operation. The grinding of this oc-

cupied 1 hour. The last operation was grinding the built-up gun, which was done in 2¾ hours, removing about 1/32 inch of material from its diameter. The length of the gun was about 13 feet and the total time for grinding was 6¼ hours as against some 50 hours in the lathe for the same work, with the advantage in the grinding machine of a superior job.

### European Car Axles

For the finishing of railway passenger-car and wagon axles, as well as locomotive axles, the grinding machine is now considered an economic necessity, at least so far as Germany is concerned, and has in fact been almost made a feature of the contracts made with the Prussian state and other Mid-European railway companies. The fact that nearly all these companies are state owned and have in each case appointed inspectors to supervise their work in each of the factories, calls for and insures a more highly finished axle than is usually the case with private railway companies who have their own plant. In fact some of the points they insist upon regarding as necessary would perhaps appear as absurdities to the more practical American or Englishman, but when we consider that many firms in various parts of the country are engaged in this industry the high grade of accuracy demanded seems more reasonable; for instance an axle produced in southeast Germany may possibly at some time have to be run in boxes made in the northeast of that country or some remote part of Europe.

Several attempts had been made to grind these axles previous to the year 1904 but although the results obtained were highly satisfactory the cost was thought to be too great as compared with the ordinary method of finishing with hand tools, which by the way was the common method and was speedy and cheap. In that year a large concern in the Düsseldorf district put in an 18x 96-inch Norton plain grinder as an experiment, and the results were so gratifying that a "repeat" order resulted and two years ago this firm was producing 1000 axles per month with the two machines and have probably improved on that in the intervening time. The superiority of the ground surface of the journal over that which had previously been obtained by hand work was in itself a recommendation to the appointed inspectors but the greater uniformity of sizing was still more so and resulted in pressure being put on other makers to fall into line.

### A Wheel Shaping Device

It was at first the practice to grind the parallel portions of the axles only, then to return them to the lathe where the radii or fillets were cut out by hand tools; now it is the general practice to grind the fillets also with the saving of much time and altogether more satisfactory results. For forming the required curve on the wheel the Norton Grinding Company provide a neat fixture with their machine which is shown in Fig. 4. In this view *A* is the diamond tool, *B* is the swinging frame in which the diamond tool is held, *C* is the set screw for holding the diamond. *E* is the handle of a plug which is inserted in a taper slot in the swinging frame whenever the fixture is desired for truing the face of the wheel. When radial truing is done, this plug is withdrawn. *F* is a hole in the axis of the swinging frame in which a stud is inserted that is used for setting the radius of the diamond point. This swinging frame revolves on ball bearings in order that there may be no lost motion at any time; these ball bearings are adjustable to take out all lost motion. For whatever radius is required to be formed a stud must be turned of a corresponding diameter which fits in the axis of the fixture. The diamond is first clamped in position with its point touching this stud, the stud may then be removed and the wheel turned to shape.

### Method of Handling Axles

It may be of some interest to describe the manner in which the axles are ground and the general machining, which is as follows, as practised by one of the most modern plants: The forged axles are first rough turned in special lathes which grip them in the middle and the journals, wheel seatings, etc., are rough turned by a tool at work at either end; about 0.5 to 1 mm. is left for removal by grinding and a coarse feed is used for turning, the fillets being turned approximately to shape. In the same lathe the axles are cut to length and then taken to another machine to be recentered; for this purpose the journals are run in roller steadies and centered in the usual way, the axle being driven direct by a belt from the overhead works. In the grinding machines the wheel seating is ground with roughing cuts to a fixed size (and it is found an advantage to leave this surface as coarse as possible for the pressing on of the wheel), the dust-proof seating is next rough ground, also the collar on the end of the axle and then we proceed to grind the journal. In the Norton plain grinding machine the table stops may be so arranged that the table trips automatically about 1/16 inch short of the point from which they are set which is an especial advantage in this class of work. In grinding these journals the stops are set as dead stops so that the wheel cannot pass beyond the width of the journal as shown by dotted lines in the sketch, Fig. 2, at the same time when traversing automatically it trips a little short of this distance. The journal is first roughed down to within 0.05 mm. of finished size by the automatic feed and then the face of the wheel is nicely trued up, after this the journal is nicely finished to size (care being taken to note the position of the ratchet wheel when down to size), the wheel is then moved back and the table brought up by hand to the dead stop, radius *A* being formed first and then *B*, feeding the wheel steadily into a point which it occupied in grinding the journal. It is then allowed to take one chip across the journal to match up with the forming cuts at either end, and after this the dustproof seating and collar are just touched up and the axle is finished.

### Surface Finish Obtained with a Flat Ground Pebble

The steel from which these axles are usually made is of a quality which will not take a high finish by the ordinary methods, but by just glazing the wheel slightly with a flat ground pebble a fine luster may be obtained. This must be applied very lightly or the wheel is likely to be put slightly out of truth, or else cause slight chatter marks on the surface of the work; a pebble ground to shape may be used to dress the radius on the wheel.

Axles of the size shown I have ground at the rate of four in 2 hours 10 minutes, including all the handling and changing over and I have good reason to think that the pace has been accelerated by the operators of two separate firms. In one factory at least my suggestion was acted on of cutting off the axles to one dead length, also centering them to one depth by means of a dead stop on the centering machine spindle. With this arrangement, which entailed no extra work, there was no necessity to set the stops for every axle as had previously been the case, and some little percentage of time was gained; it also simplified the gaging and resulted in a much more easily duplicated form of axle.

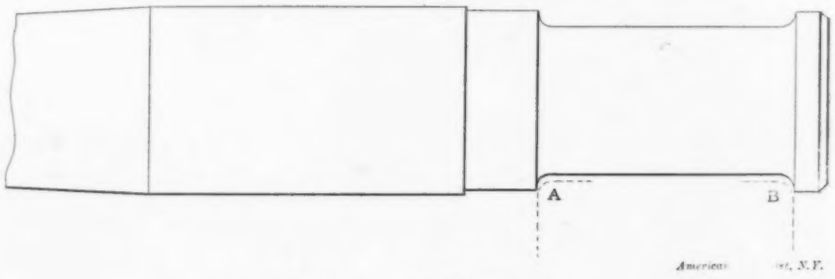



FIG. 5. CAR AXLE GRINDING

# Leonardo da Vinci, as Engineer and Machinist

## The Universal Genius Who in Every Field of Human Knowledge, Art and Invention, Excelled All Other Men That Ever Lived

BY EDWARD P. BUFFET

The wise beware of superlatives. To pronounce any man or any machine "the greatest" or "the best," is a presumption which invites contempt. Were the question asked: "Whose is the most exalted genius that the world has known?" it would sound like an idle riddle, to be answered according as the hearers preferred various qualities that enter into genius. Few Americans, in any event, would cite the name of Leonardo da Vinci. Yet none can examine the relics of that mysterious Florentine without finding proofs of an intellect beside which those of Cæsar and Shakspere dwindle to meanness.

LEONARDO DA VINCI, ARTIST-ENGINEER—AFTER ENGRAVING FROM A PORTRAIT

Leonardo's reputation is well enough established as a painter in a class with Michael Angelo and Raphael, but his name strikes the ear with little suggestion of gifts other than those of a pictorial artist. Yet this was only one manifestation of a mastership which comprehended every branch of art, science and industry.

No other man ever came near him as a universal genius. None ever had half so many specialized brain cells. In several of his activities independently he is a strong claimant for premiership of excellence, while the combination of his accomplishments makes his superiority overwhelming.

To any mechanic it must be a ground of pride that the artist hand which endowed the Italian Renaissance with works second perhaps in merit to those which remain from the age of Phidias should have busied itself no less eagerly with tasks of engineering and machine design. As a creative power in mechanism the rank of da Vinci is not secondary, but incontestably he is entitled to first place in history.

As we turn over the vast collection of sketch books left by Leonardo, filled with assembled machines and details, roughly outlined like the common-place notes of any present-day designer, yet enlivened with a grace and confidence of stroke, an expressiveness of meaning such as no other draftsman ever gave, there arises a feeling almost of awe and a conviction that nothing which may help us to understand the personality of such an engineer can be without value for his modern fellow craftsmen.

### Leonardo's Multifarious Works

In science and technology he was a true prophet, both as a fore-teller and a forth-teller. So little is known of the mechanical proficiency in his time that we cannot be sure how much of his work was founded on that of others and how much was original. But it is certain that he forecasted the years which were to come after him, outlining the progress of the future by notes and sketches, most of which remained hidden away while other men won fame by puzzling out singly the problems that he had solved *en masse*.

Of the achievements ascribed to him, some may rest on tradition or inference, but very many are amply attested by his own hand. Without pausing to discriminate sharply as to the respective evidence for them, a partial summary of his alleged accomplishments may be given at this point.

Leonardo anticipated Copernicus in forming a just conception of planetary motions. Before Newton he apprehended the principles of gravitation; he was familiar with the laws of motion. He was aware that the earth revolved; he attributed the tides to solar attraction. Like Galileo, he discovered earth-shine on the dark of the moon; he also perceived the burnt-out condition of that satellite. He noted that the apparent size of the stars increases toward the horizon, and he distinguished their scintillation as a phenomenon independent of themselves. He established the relation between the dilation of the eye pupil and the intensity of light. He speaks of "constructing glasses to see the moon large," a single

lens though this may be. He is credited with making also a camera obscura. It is said that he invented the barometer afterward realized by Torricelli and directed his studies toward the thermometer, for which Galileo has received honors. He likewise conceived a hygrometer, a compass with movable center and a most improved form of the balance.

While yet Harvey was unborn, Leonardo observed the circulation of the blood. Before Darwin he found in the horse rudimentary muscles and unused organs—a "water stomach." Centuries before Cuvier he reconstructed extinct animals from fossil remains. There have been ascribed to his perception the molecular composition of water, the motion of waves, and the undulatory theory of light and heat. Not only was he skilful in the practice of music, but adept in the theory of acoustics. He built musical instruments on scientific principles, observing the transmission of sound waves in space. He studied the echo and its angle of production; in times of tempest he measured sound velocity.

He studied combustion and called smoke "fire without air," thence inferring that fire feeds on air. He investigated the possibilities of steam power and designed a steam cannon. Steam pumps seem also to have been in his mind. Moreover, there is one of his sketches which, though obscure, has been thought by some to indicate a steamboat.

Mathematics he followed far, and made many geometrical discoveries. He studied the formation of the regular polyhedrons; he was the first in Italy to employ plus and minus signs. One of his myriad mechanical investigations was concerning the power of a lever moved on an inclined plane.

In hydraulics alone he did enough to furnish fame for several men. Until he arose, so far as we know, that branch of physics had been neglected from antiquity. His canal, irrigation and harbor engineering gave him plenty of opportunities for applying it. Thus, he had occasion to solve such problems as, the quantity of water required to fill a certain canal, and the length of time it should run. In recondite diagrams he depicted the contours of different jets issuing horizontally from orifices. A mill pipe, he found, is not filled by parallel threads of water, but by periodic eddies or currents, the vertical axes of which shift their position.

Many were his inventions relating to this favorite element, water. Pumps of complicated design occupy large space in his books. He designed novel buoys, diving apparatus, and the first life-preserver. Among the earliest canal locks were his. His drawings display dredges of different types and gigantic machines which were to be advanced along the canal bed for systematic digging on both sides.

Liquids were not the only fluids that he studied, but his researches extended to the gaseous realm. Thus, he treated the resistance, or pressure, of the air as dependent on its weight. He measured its density and, as already mentioned, he devised the most important meteorological instruments. His elaborate work in the study and imitation of wings should be classed rather with mechanics than with pneumatics. For he displayed great ingenuity in the design of flying machines, ornithopters and helicopters. He also knew the use of the parachute.

In Leonardo's industrial machine-designing there is most of marvel. Mechanical details that never would be ascribed to the beginning of the sixteenth century and complete apparatus of infinite variety and purpose luxuriate in his huge note books. Cams, levers, gears, worms, ratchets, sprockets and chains abound in almost every pattern, ancient or modern. We find rolling mills, draw benches, power hammers, cranes, shears, threading machines, file-cutting machines, rope-making appliances and metal or wood-working tools, such as lathes, planers, boring mills, boring jigs, self-centering chucks, bending machines and broaches. A stone-cutting saw of his invention is still used in the Carrera marble quarries. He was far advanced in the use of automatic machinery for needle-grinding, gold-beating and other purposes. He planned many patterns of radius grinders for use in the manufacture of concave reflectors.

During the Medicean age, Florentine fabrics were celebrated; it was therefore natural that some of Leonardo's most recondite designs should appear in textile machinery. He laid out a complicated multiple cloth cutter, a gig, looms, etc. Yet, in da Vinci's time, as in our own, the constructive arts were largely subservient to those of destruction. Military engines engrossed an inordinate share of his attention. Those which he designed follow a line of contact between ancient and modern warfare. On the other hand are catapults, ballistas huge cross-bows bent with windlasses, and instruments for scaling and battering down fortress walls. On the other hand are breech-loading cannon, divers types of artillery carriages, various forms of multiple-barreled guns. He laid out machines for drawing and rolling iron staves used in artillery manufacture and he shows a thorough knowledge of foundry practice. He studied also the composition of explosives. Whether he invented any instruments of torture is not disclosed by a superficial examination of his books, but if he did he found a ready market for them in Italy of his day.

It is hardly necessary to add that Leonardo dabbled in chemistry, particularly in the mixing of pigments, and it is only candid to admit that along this line his results did not uniformly add lustre to his reputation. The skill which generally he displayed therein is obscured by certain spectacular failures, much detrimental to his artistic output, as will appear from the sketch of his life hereinafter following.

To prolong adequately this bill of particulars would lead us far into architecture, geology, botany, zoölogy, anatomy, linguistics and indeed over nearly all the fields of human knowledge. As has well been said, Leonardo combined the artist's gift of creation with the mechanical inventor's ingenuity and the philosopher's passion for truth. In the third of these characters, as well as the first two, he was gifted to shine; his recorded reflections entitle him to rank as a philosopher; his critical, epigrammatic writings and his attributed poetical compositions do him credit in the province of literature.

### The Man, His Heredity, His Environment

Heredity can no better account for Leonardo than for a white crow. Born 450 years ago (1452) as the natural son of an undistinguished notary and a peasant woman, he entered the world well-favored to perfection, physically and mentally, an anticipatory instance of the superman.

In no way does he appear more to advantage than as tested by that exacting Aristotelian judgment which holds excellence to reside, not in essence, but in proportion; which regards as good or bad that which is fitly or inordinately blended. His moral qualities, like his talents, were tuned to harmony. Reticence and geniality, meekness and self-assertion, peacefulness and belligerency, orthodoxy and heresy, beauty and utility, theory and practice, were adjusted to the finest poise. The sanity of his mind was Grecian, yet better than Grecian; it was that sanity which caused him, a century before Francis Bacon, to let in the daylight of modern applied science.

While no man ever made better use of his opportunities than da Vinci, no one ever lived whose opportunities were better. Standing where he did at the meeting point of the ages, he was permitted to do what no engineer had so freely done before—what no engineer can do now or hereafter—to bring forth out of his storehouse things *new and old*.

We study ancient history to gratify curiosity or human interest, but we have pressed so far beyond it mechanically that no chance is left of finding anything in it that can help us technically. "In literature read nothing new, in science read nothing old." But when Leonardo came the richest scientific wisdom was in a treasure house of antiquity where it had remained undisturbed for over 1000 years waiting for him to open the door and make it all his own.

Little vitality had moved in physical learning since the ages when fleets of republican Rome had been enkindled by mirrors of Archimedes; when his analysis had

fathomed the dynamic mysteries of water; when Heron's fountains had played in laboratories of Alexandria, and the oil of Carthagenian olives had flowed from Cato's cunningly contrived presses.

Already for a thousand years the dwindling traditions of secular knowledge had been severed in the West by the fall of the Empire, and since then little care was given to any but superstitious letters. Applied science could scarcely flourish where pure science was abhorred. Chemistry, physics, mathematics, astronomy, were regarded as black arts, and books upon them were burned with the authors, whose condemnation for sorcery, if their intent sufficed, was often not unmerited. Booklore, aside from this, was made up of unprofitable subleties concerning the dreariest of dogma.

Influences to a revival of learning came not only through chance acquisitions from the East in the Crusades, but through pupilage to the cultured Saracens of Spain, from whom Latin scholars gratefully received algebra and medicine at the universities of Cordova and Toledo. But the new life was directly ushered in by the fall of Constantinople, which drove into western Europe the savants of the Greek empire with their feebly understood, but still cherished, manuscripts of the old philosophers. This occurred a year after the birth of Leonardo, who thus became heir of antiquity.

### Experience and Utility

Francis Bacon is credited with having established the modern policy in science. A hundred years earlier, Leonardo da Vinci had laid down that policy and had consistently acted upon it.

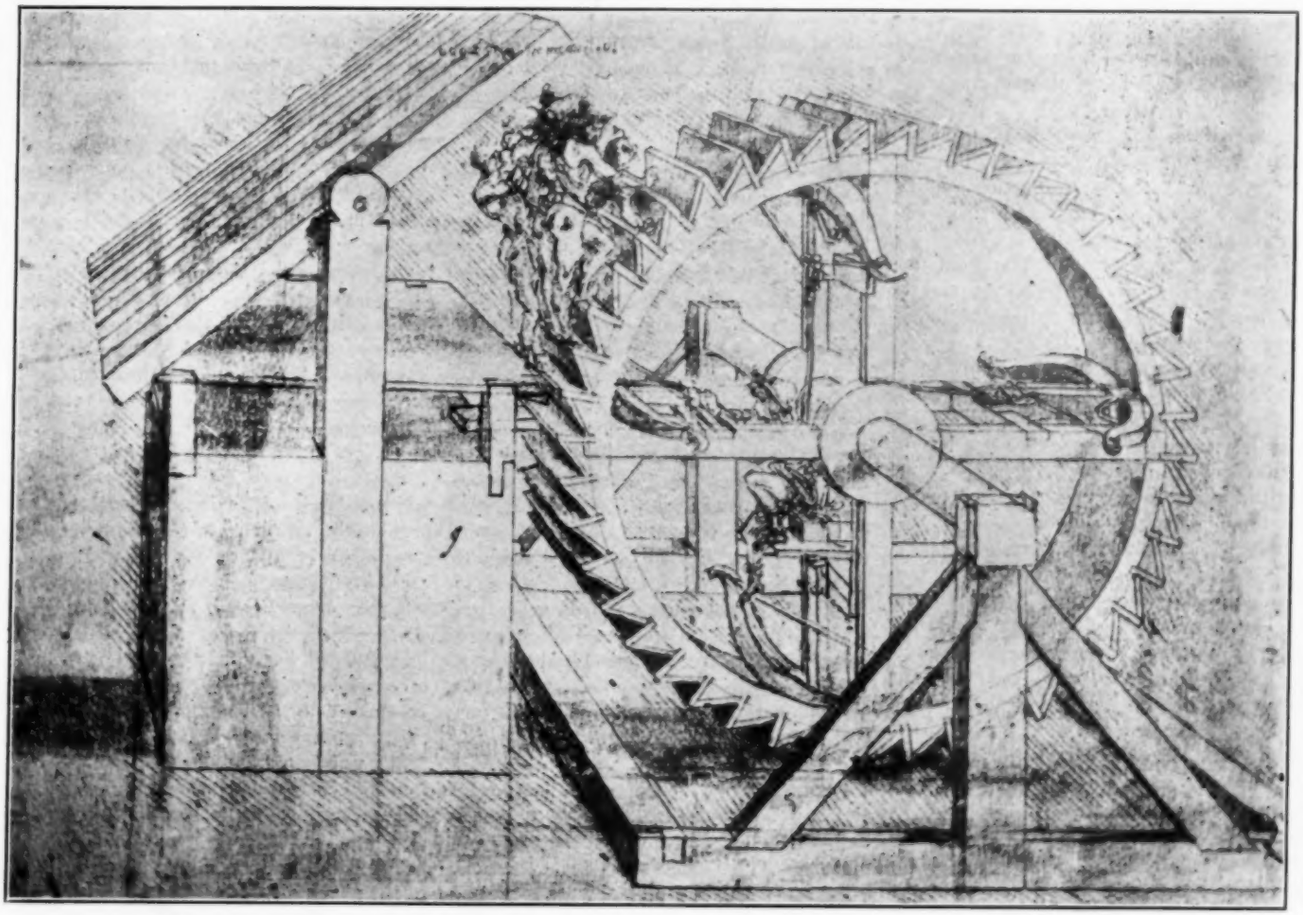
Every school boy knows that the novelty introduced by Bacon was inductive reasoning, but every school boy knows something which is not so, for men have always reasoned inductively; the oyster reasons inductively when he learns that opening his shell lets the water in. Rather, as Macauley has pointed out, Bacon's revolution consisted in turning men from speculation to objects that could be attained only by induction, and by induction carefully performed. The keywords of his doctrine were *utility* and *progress*.

Usefulness was despised even by the best and wisest of the ancients. Seneca, the Stoic tutor of Nero, rejected as an insult to Philosophy the notion that she could have taught the use of metals or improved a ship, plow or mill. He sought to disprove, as shameful slanders, that Democritus had designed the arch and Anacharsis devised the potter's wheel. "In my own time," he said, "there have been inventions of this sort, transparent windows, tubes for diffusing warmth equally through all parts of a building, shorthand, which has come to such a perfection that a writer can keep pace with the most rapid speaker. But the invention of such things is drudgery for the lowest slaves; Philosophy lies deeper. It is not her office to teach men how to use their hands."

Socrates had praised astronomy because its effect is to raise the mind to the region of pure truth. Plato valued arithmetic chiefly for the same reason and he rebuked Archytas for constructing high-power machines on mathematical principles, since this degraded a noble intellectual exercise into a low craft, fit only for carpenters and wheelwrights. Even Archimedes was ashamed that the creations of his genius clothed themselves in matter.

Such were the influences which freed Leonardo's generation from the still more impractical scholasticism of the Dark Ages in which it had been produced; but he was bound no more by Classicism than by Medievalism; with the force of his instinct, he burst out to the wider liberty of Modernism.

It was creditable for Bacon in the



QUADRUPLE BALLISTA OPERATED BY TREADMILL, FROM CODICE ATLANTICO, 387—EXAMPLE OF FINEST ART COMBINED WITH MECHANICAL DRAWING

Elizabethan era to declare that trees of learning must be judged by their fruits—not merely by their flowers and leaves—but long before him da Vinci had remarked:

"Mechanics are the paradise of mathematics, because here we come to the fruits of mathematics."

### Leonardo's Creed—Theory and Practice

Read a few more proverbs of science from Leonardo's notes and observe how intensely Baconian he is, both as to the useful object and the experimental method; yet how he preserves a balance between concrete and abstract processes:

"Every instrument requires to be made by experience."

"It is necessary to begin by experience and, thanks to her, to discover the reason of the phenomena."

"Instrumental or mechanical science is of all the noblest and most useful, seeing that by means of this all animated bodies that have motion perform all their actions; and these movements are based on center of gravity, which is placed in the middle, dividing unequal weights, and it has dearth and wealth of muscles and also lever and counter-lever."

"Experience never errs; it is only your judgments that err by promising themselves effects such as are not caused by your experiments."

"Experience does not err; only your judgments err by expecting from her what is not in her power. Men wrongly complain of Experience; with great abuse they accuse her of leading them astray, but they set Experience aside, turning from her with complaints as to our ignorance causing us to be carried away by vain and foolish desires to promise ourselves, in her name, things that are not in her power; saying that she is fallacious. Men are unjust in complaining of innocent Experience, constantly accusing her of false evidence."

"The man who blames the certainty of mathematics feeds on confusion and never can silence the contradictions of sophistical sciences which lead to a sophistical quackery."

"There is no certainty in sciences where the mathematical sciences cannot be applied, or which are not in relation to these mathematics."

"Science is the captain and practice the soldiers."

"Those who fall in love with practice without science are like a pilot who enters a ship without a rudder or a compass and who never can be certain whither he is going."

"Be assured that it is necessary to study with system and patience the nature of the objects that one wishes to reproduce; otherwise he loses his time and very uselessly prolongs the work."

With what a shock to an age which still revered Bernard and Aquinas must have fallen da Vinci's "Treatise on Painting," containing such a doctrine as this:

"No human investigation may be treated as pure science if it does not pass through mathematical demonstrations. When you say that those sciences which begin and end in cogitation have also their truth, I deny it on good grounds. I will not admit that in such reasonings experience is of no account, since without experience there cannot be a bit of certainty."

"It is said that mechanical knowledge," remarked Leonardo also, "is that engendered by experience, and the scientific that which is born in the spirit, while the semi-mechanical is born in science and ends in a manual operation. But it seems to me that those sciences are vain and full of error which are not born of experience, mother of all certitude, and which do not lead back to verification in experience; that is to say, whose origin, means and end do not pass through any of the five senses."

### Universal Perception

Those who are best qualified to know Leonardo have divined that the supreme condition of his liberty was solitude. Though far from being an unsocial man, there was in him a necessity for isolation of mind. He expiated his privileges with loneliness.

While his genius was "universal" in the practical sense of a complete horizon, it was such too in the philosophical sense of grasping "universals," or even in the mystical sense of entering into close communion with the universe. Something akin to that state of mind, so elusive of definition, which mystics profess to experience, seems to dominate a few sane, observant and creative minds who are at the furthest possible remove from mysticism in the results they produce.

The Medicean age, when he lived, was one of introspection; a Swedenborg or a Pascal would have been more at home in it than a Goethe or a Newton. Leonardo's output, however, is of a sort that indicates little self-consciousness, but rather a broad interest in the things and people around him.

May we not affirm that in his hours of brooding he was gazing, not *at* himself, but *through* himself at the Macrocosm? That in this way he enjoyed a scope of vision and power of generalization which even his omnivorous curiosity could not have reached by its convivial exercise? That his nurtured intuitions were more prolific than mere study could have been? That, in plain words, the best understanding of men and things is not always gained in constant companionship with them?

Amiel, a man of subjective bent, very unlike da Vinci, has described his own fits of abstraction in words which may furnish a clue to Leonardo's mind:

"I am a spectator, so to speak, of the molecular whirlwind which you call individual life; I am conscious of an incessant metamorphosis, an irresistible movement of existence, which is going on within me, and this phenomenology of myself serves as a window opened upon the mystery of the world."

The generalizing skill in portraiture, which Leonardo shared with others of his artistic school has been verified by a mechanical test of recent times. With "composite photography" the faces of several persons may be superposed and blended; if they belong to a special class the resultant emphases of feature distinguishing them from groups otherwise composed may be taken as characteristic of the class. This device has proven the accuracy of Renaissance painters in depicting typical physiognomy.

But, if it be true that genius reaches profound conclusions "intuitively," this does not mean that the mind really ignores details or reasons loosely, but rather that the hard work is done in the subconsciousness. Intellectual bricks cannot be made without straw, and great results can come only from a great brain. Astounding was the precision of Leonardo's mind and eye. When dividing the human figure in his measurements, he counted "degrees," "points," "minutes," "minimes," and "semi-minimes," these forming a duodecimal series the smallest of which is a 248,832nd.

### Unity

Stimulating to the modern engineer as may be the unlimited scope of Leonardo's genius, a rarer inspiration is derived from its *unity*. Other men have been versatile, but they have kept their talents in separate compartments of the mind. They have turned from one avocation to another for change and contrast. The poet has cooled his brain cells by chair caning or poultry farming, while the fashioner of brass and iron into useful shapes has flown from the monotony of his work to the strains of flute and violin. Yet, for the ordinary man his several activities are in nowise related—no more than for the savage are the sea currents which bear his boat with the moon which lights his way.

For Leonardo all the laws of truth, whether in science, art or industry, were consonant expressions of the same omniscient Nature. On those drudging members which other men esteem less honorable, he bestowed more abundant honor, and this he did, not by segregation but by association. There was no forced elevation of Mechanics at the expense of the fine arts, but a free social equality between them, with mutual help and dependence. Power and Utility were shown to be blood relatives of Taste and Humanity. Our present-day practician who cannot quite rid himself of a sense of squalor in his mental, as in his physical, surroundings, should learn his dignity from Leonardo.

The reason that the example of this old Florentine is almost as fresh and needful to us as it was to the men of his own day consists herein: *That Leonardo not merely believed in unity, but lived it.*

A theoretical acceptance of Nature's oneness has become commonplace. This was not so always. Our Aryan progenitors supposed that the different manifestations of the physical universe were impowered by independent deities. The sun, the sky, the darkness, the dawn, the rain, the lightning, were actuated to regular or capricious changes by separate in-dwelling spirits. As the human mind has progressed it has tended to fuse these divisions of control into a single Power. One of the most fascinating studies in the history of thought is to follow the paths along which, from exceedingly remote times, Pluralism, as a conception of Nature, has been yielding to Monism.

To our minds it has become a truism that all things which move are inflexibly geared together. For Leonardo, before the time of Paracelsus, to perceive the same, was an honorable feat, but had he done no more than that he would scarcely be required for our emulation. What distinguishes him as a model unique for all time is his *realization* of his scientific faith; he was its vital exponent.

Science was to him the schoolmaster of industry, and mechanics the preceptor of art. Painting was applied anatomy, and anatomy was explained by the laws of the lever. As an ornithologist he wrote a treatise on the flight of birds, which was a kinematical study, and on this he based the principles of the air-ship. If the flying machine ever be perfected, it will follow, as he foresaw, the pattern of winged animals, just as the fleet vessel must approximate in contour to the fish and every optical instrument must simulate the eye.

Optics was one of the sciences that Leonardo studied profoundly and applied in his pictures. Perspective he well understood; his notebooks reveal how he scrutinized the human countenance from judiciously chosen viewpoints. Binocular vision he found intelligible and employed to advantage. His figures are artfully caused to stand out in space by sharp delineation of the important features, toward which the observer's eyes will instinctively converge, while a soft obscurity evelopes those lines which naturally will be seen out of focus.

For Leonardo neither esthetic nor industrial products were an end exclusively, but he coördinated them as objects of intrinsic worth and called upon the methods of both to lend reciprocal assistance. To the gears and levers of his mechanical sketch books he deemed it not ignoble to devote those pencil strokes which might have outlined a Madonna or an Adonis. Botanical studies aided him in adroit imitation of foliage. The crests of breaking waters, whose powers he measured, were molded by his fancy into grotesque shapes which his pencil congealed.

"Especially where there is relation and proportion," wrote Leonardo, "is there a place for calculation; and the proportion is found not only in numbers and measure, but also in sounds, weights, times and places, and in every force, whatsoever it be."

"Mathematics," said he," are necessary to the painter for the painting forms a part of them."

"Painting is a new creation of nature; it embraces all the forms of the visible. . . . . Perspective is the brake, the rudder, of the painter."

"The science of mechanics is as universal as that of painting, for every action is produced by motion and motion is the cause of all life."

"There is no sound without motion," he remarks, "and no motion without force. The force is caused by the motion in the weight. The blow is born of the weight and the motion."

A certain breadth of functions was common among da Vinci's contemporaries. Michelangelo and Raphael were architects as well as artists. Responsibility for the effect of a painting did not end with putting on the pigments. I translate from Paul Errera, in the *Revue de l'Université de Bruxelles:*

"With the picture the artist composes the frame; with the fresco the entire decoration of the chapel or hall: marble, wood, stucco, wrought iron, all come out of the same shop. The saying is found in Vasari a propos of Verrocchio: 'Herein is the supreme harmony of the beautiful works of the Renaissance—they are conceived for a determined position; they fit their surroundings, and their proportions are calculated, as are those of the architecture; to which they are connected, moreover, with a thousand perceptible bonds.'"

### Incidents of da Vinci's Life

Leonardo's birthplace, which gave his surname, was the village of Vinci, in Florentine territory. His father, Piero, son of Guido, was a lawyer in a line of lawyers. Soon after Leonardo's birth, which occurred in 1452, his peasant mother, Caterina, married a man of her own rank in life, but Piero brought up the boy in his house with the advantages that his fast-growing means afforded.

In the studio of Andrea del Verrocchio, at Florence, da Vinci spent his youth, learning to draw and paint, to model and chisel, to found and weave. With the brush he soon became so surpassingly proficient as to inspire a legend that he drove his master to abandon the profession in chagrin.

Anatomy of the body taught him what to draw, while anatomy of the eye led him into subtle confidences with the observer whom he wished to impress. A Pre-Raphaelite in very truth, he ignored tradition and learned from nature wisdom in portrayal. When his fancy passed from the beautiful to the grotesque, his scientific spirit led him to produce a heraldic dragon synthetically from reptiles and insects.

While developing his powers, Leonardo did not neglect the amenities of life. Vivacity and magnetism of temperament, generosity of disposition, were joined to a physique of combined strength and beauty which dazzled his contemporaries. It is handed down that he could twist horseshoes in his fingers and ride unbroken horses. Such a glow he left in the world that after four centuries Robert Louis Stevenson could write: "Of the misbegotten changelings who call themselves men, and prate intolerably over dinner tables, I never saw one who seemed worthy to inspire love—no, nor read of any, except Leonardo da Vinci, and perhaps Goethe in his youth." No picture of Leonardo in his young manhood remains, and how he then looked we can but dimly infer from the hirsute portraits of his mature years.

The age of Lorenzo de Medici was dawning upon Florence, and after Leonardo's debut as an artist *sui juris* he is found working under patronage of that magnificent prince. About 1480 lies an obscure period in his annals, and it is supposed by some that during this epoch he made certain mysterious travels in the East—to Egypt, Constantinople, Asia Minor, Armenia. It is believed that he served as engineer for the sultan of "Babylon," to wit, Cairo. His mind had early turned to mechanical pursuits and the financial unsuccess of his paintings disposed him to military architecture as more lucrative. We can only conjecture how much added wisdom he brought back from the Orient to Italy.

The prime of his career began about 1484, with the service of Duke Ludovico Sforza il Moro, at Milan, to whom he was recommended by Lorenzo. It is told that he was called to Ludovico's court as a violinist, and that he bore a curious silver lyre of his own invention. Those who thus relate do not overestimate his proficiency in the creation and theory of sound, and the incident may be founded on fact, but the main grounds for his employment by Ludovico were his ability as a military engineer and his skill as a sculptor. Among 10 qualifications confidently named by him to the duke, military engineering is prominent, although civil engineering, painting and sculpture are not omitted. At this time he bid for work which subsequently, in a procrastinating manner, he carried out—the huge bronze equestrian statue of Ludovico's father, Francesco Sforza. The fortunes of war soon gave this ponderous image to destruction.

At Milan, da Vinci's activities and studies were multifold. Intermittently he built war engines, planned court pageants, researched in optics, geometry and an-

atomy, and engaged in vocations too varied to describe. He improved the Martesana canals, thereby enriching the city, and he benefited the agriculture of Licino by irrigation. In this period he painted the "Last Supper," which shares pictorial supremacy of the world with Raphael's "Sistine Madonna" and Michelangelo's "Last Judgment." Before the end of the 10 years during which he labored by fitful intervals on this mural masterpiece, the monks whose dining room it was to adorn grew tired enough of waiting for its completion, since Leonardo's art was long in realization of his conceptual types, lax in application and infinitely painstaking in detail. The remark has been made of him that he finished nothing, or if he finished, it was only to commence anew. Unhappily, this painting furnishes an instance where his alliance of art and science was fickle, for, anxious to obtain the unusual effect of oils in fresco, or to employ a method that allowed more deliberation and revision than the ordinary mural processes, he taxed his chemical skill and victimized the priceless picture in an unsuccessful experiment. After repeated peelings and restorations, it is doubtful that any of the work now visible is his.

In this long term of residence under Ludovico's protection, Leonardo became principal of an academy which grew famous and which has been called the first scientific and experimental academy in Italy. He accumulated no fortune at Milan, for he was not a sharper, and throughout most of his life a bad money maker, his powers of mind and hand being appreciated by his patrons in any way except pecuniarily.

This luxurious if not lucrative period of Leonardo's life was brought to an end by the army of Louis XII of France, which entering Lombardy in 1499, soon reduced Milan and made Ludovico a prisoner. Leonardo took refuge in Venice and Florence, at which latter place he engaged in painting and other professional work. He projected at this time the canalization of the Arno and proposed to move the St. John baptistery to a new site by means of water power from the river, neither of which plans he was permitted to execute.

Some two years after the fall of Milan he placed his services at the disposal of Cesare Borgia, who was under French patronage and a bitter enemy of Ludovico. For this famous assassin da Vinci built military machines, strengthened fortifications and traveled, minutely mapping wide regions of Tuscany. He was thus commissioned private architect and general engineer of the duchy of Urbino.

His facile changes of his political clothes will be condemned especially by those who esteem "patriotism" above all virtues. The circumstances, however, were peculiar. Artists and savants were a privileged class of supernumeraries; then, too, the partisan life in Italy was mixed and shifty. But best he may be vindicated through drawing due distinction between dynastic pretensions and public interests. In the downfall of a state its proletariat have usually cause for rejoicing.

Less consistent with an immaculate character, was Leonardo's readiness to hire himself out to make gun carriages, catapults and battering rams. To be sure he followed the almost universal judgment of mankind that in preparing for war business is business. But Leonardo must be held to stricter account than ordinary men. His clear mind should have been revolted by the incongruity of his fighting machines with the sacred themes of those paintings to which he devoted himself. His imagination could indeed be touched with the "bestial frenzy" of war as a motive for a great picture. In his private dealings he was forbearant, victimized rather than victimizing. It is odd that he assumed the canons of morality binding on individuals to be annulled at the caprice of a prince or will of a nation. Like his earlier compatriot, the Saint of Assisi, he might be never so stern with himself, yet deferred obediently to external powers.

Relieved by Borgia's downfall, in 1503 from his active labors, Leonardo settled for three years at Florence, which city he might instead have been called to lay in ruins, had not the duke's quietus frustrated the plan for an attack. He there, in cartoon competition booked an order to print a battle scene for the Hall of Council. This cartoon it was, which depicted the combat of the Anghiari, the "bestial frenzy," as he called it, of war, and it may be that the choice of the subject was tinged with remorse. Again, however, science betrayed art, and failure of a process by which he had hoped to bake the picture into the wall occasioned his abandonment of the contract. Instability was one of his besetting faults. But at Florence he painted the Mona Lisa del Gioconda, for which subsequently Francis I of France paid 45,000 francs and in which biographers have sought to find the one romance of Leonardo's solitary life. He there conducted rigorously scientific studies of the flight of birds, their feathery and muscular structure and the resistance of the air, applying the results of these reseaches to designs of machines for artificial flight.

To Milan he came once more in 1506, and dwelt for several years in peace and preferment under Charles of Amboise, who was appointed governor by the French king, Louis XII. That monarch, a visitor at Milan, became an admiring patron of Leonardo, who was endowed with the dignity of his painter and engineer. Da Vinci became an honored guest and habitual dweller at the villa of Francesco Melzi, a young disciple who afterward followed him like a dog. In this term of residence at Milan he engaged in hydraulic work, including the Martesana canals again, and the basin of San Christoforo. Two other pursuits were expeditions to the mountains in the north of Lombardy to study their formation and researches in the dissecting laboratory which perfected his skill as an anatomist.

At the close of 1511, Milan was shaken by another revolution, the French party being driven out and Maximilian Sforza, son of Ludovico, coming in. Two years later Leonardo turned his face toward Rome, where Giovanni da Medici, son of Lorenzo, was Pope. The successor of St. Peter was pleased at first with da Vinci's curious scientific experiments, more so than with those which later he undertook in concocting a new unctuous medium for a picture that he had been commissioned to paint. But suspicions of necromancy or heresy were aroused against him and even heeded by the Pope. His anatomical dissections were deemed especially an offense. On the whole, he received little encouragement at Rome, therefore he turned from his brushes to birds and air ships and ere long quitted the city. It has been suggested that he was injured through Michelangelo's jealousy. This young contemporary shared a little of Leonardo's versatility and worked as architect on St. Peter's church. The same is true of Raphael, whose artistic production was done by hatching the eggs that Leonardo had laid. With all due respect for the junior members of this triad, it seems to be a descending scale.

Rome's atmosphere of chill for Leonardo could have caused him few shivers; he was fortunate that it caused him no burns. He cared little for the canons of the Hierarchy and his note books bristle with caustic epigrams on the monks of that vicious age. While he lived and died a nominal Catholic, and got along better than Galileo, his spirit was that of the critical Erasmus though hardly that of the austere Savonarola. Leonardo was indeed an inveterate free thinker, though not in the sense of being an irreligious man, as is evidenced both by his sympathetic treatment of sacred themes for painting and by his ascriptions, as a man of science, to the Prime Mover of the world, Creator of Power and Order.

Yet once more Milan was entered by the French, whose king, Francis I, then come to the throne, added to the favor of his predecessor toward Leonardo an adoring enthusiasm. By his invitation the artist left Italy for France at the close of 1515, followed by Francesco Melzi, and took up a residence at Chateau Cloix, in Touraine.

There he lived, doing a little painting and canal work, until he dropped away. This occurred in 1519, his sixty-seventh year, when age had palsied his hand but had not sapped his intellect.

"I do not believe," said the king, "that there is in the world another man as wise as Leonardo, not only as sculptor, paintor and architect, but as a profound

philosopher." This verdict may stand until the next superman appears.

It has been alleged that Leonardo wasted his talents by diffusion of effort and that his actual accomplishments were comparatively slight. Therein is a half-truth. His paintings were few compared with Raphael's and most of his inventions were still-born. Had he specialized as men specialize today, he would have achieved something so spectacular as to be the world's transcendant marvel. But for conviction that his definite results were tremendous, it is needful only to examine the records which he left behind. Rarely were his discoveries followed up, yet that does not belie that he made them.

### Leonardo's Remains

Of Leonardo's literary output, the work that has longest been published, though not in his lifetime, is his "Treatise on Painting." He projected various others, such as a "Book of Motion," "Treatise on Impact," "Machine Elements," "Book of Gravity" and "Book of Momentum." These, if completed, are said to be lost, but no doubt many of the ideas contained in them have been preserved elsewhere in his teeming and bewilderingly arranged manuscripts.

Data of his long productive years were kept by him in the form of notes and drawings covering thousands of sheets. A single page would contain, say, a bar-bending machine ensemble, details of ratchets and worm gears, the design of an architectural cupola, the study for a grotesque head, or a philosophical sentiment —any of these subjects dovetailing into the odd corners left by others on the paper, as they did in his mind. It was his purpose to classify his manuscripts, but his death left them unassorted.

By testament they passed with his other chattels to his famulus, Francesco Melzi, who brought them back to Italy and cherished them for 50 years. After Melzi's death some of them fell into the hands of one Mazzenta, who, being convinced that he had no right to them, restored them to Dr. Orazio Melzi, a gift which the latter requited by bestowal on him of many manuscripts. But Pompei Leoni, sculptor and brass founder to Philip II. of Spain, was then living in Milan, where he had accumulated an art collection. He induced Melzi to bid from Mazzenta the volumes before rejected; in this way Leoni obtained seven of them and otherwise got hold of three more. These manuscript books were taken apart for him and rebound in a great volume, 18x27 inches, with an arrangement, or lack of arrangement, attributable to the convenience of the binder. More than 1700 groups of drawings were comprised in 402 folios, windows being left in the leaves for matter on the back sides of the sheets. By reason of its magnitude or atlas-like character, this collection became known as the "Codice Atlantico."

This Codex was carried by its owner to Madrid but brought back to Milan and lay in the Ambrosian library until 1796. In that year it, with twelve or fourteen other volumes of Leonardo's manuscripts, was stolen by Bonaparte and sent to Paris as loot. After Waterloo it was returned to its Italian home, where now it rests. The minor manuscripts, however, had been deposited in the Institute, at Paris, instead of the National Library with the Codice Atlantico, and by an oversight they were not restored to Italy then nor have they been since. Within the last 20 years they have been published under the editorship of Ravaisson-Molien, in fac-simile, accompanied by the deciphered text in both Italian and French, thus filling six huge folio volumes.

Still more lately the Accademia dei Lincei, at Rome, with governmental aid, has completed a limited edition of the Codice Atlantico in facsimile plates mounted on large sheets like drawing paper. The process of reproduction is superior to that used for the French collection, but there is no transliterated text. This is more of a drawback for the casual researcher than might be supposed, and unless he has learned the trick of Leonardo's chirography, he will find it as incomprehensible as Arabic. The characters are small, detached letters, fairly clear, but at first stubbornly defying interpretation. The difficulty is lessened, if not entirely removed, by information that Leonardo, who was left-handed, habitually wrote backward, so that the manuscript must be read as in a looking-glass.

Other collections of da Vinci's sketches and writings are preserved in European libraries, including those of Florence and Venice, of Windsor and the British Museum. After long obscurity, much of them has been published. Among them is a little notebook on the Flight of Birds.

But no other equals in importance or interest the Codice Atlantico. This work may now be seen at the New York Public Library and probably at other large ones in the United States. Rarely does anybody ask to look at it; but either artist or engineer who fails to spend at least a day in its persual is contemning the most majestic documentary monument of his profession.

Huge facsimile editions like those that have been described are manifestly, however, unavailable for general use, and a digested classification of the matter contained is imperative for any but the most leisurely reader. No illustrated popularization of the scientific material in either the Institute collection or the Codice Atlantico has, to my knowledge, hitherto been brought out in the English language. This has been done in France by M. A. Ronna, who, in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* has described da Vinci's hydraulic machinery from the Atlantico, with a long sketch of his life; and in Germany by Professor Beck, who has treated his mechanical output quite exhaustively. The former has been helpful in preparing the present article; to the latter, special credit may be reserved for a future paper in which we shall examine some of Leonardo's work.

## Types of Turrets for Screw Machines and Turret Lathes

By C. L. Goodrich*

It is interesting to look through machine-tool catalogs and advertising columns of mechanical journals and note the various types of revolving or turret tool-holding heads that are applied to hand and automatic screw machines or turret lathes.

While it is probable that the form of the turret has in some cases been made so as to conveniently permit of a specific machine construction otherwise difficult, it is evident that in the majority of cases the form of turret has been one of the principal considerations in the design of the machine; the character of the work, particularly its dimensions being a determining factor in the selection of the type of revolving tool-carrying head.

It may be said that at present there are seven distinct forms in which the revolving tool head is constructed and mounted.

Referring to Fig. 1 we have a circular type with cylindrical holes and with six bushing tool binders or clamps. This represents probably the most common form of turret and for short bar and chucking work it is very suitable. It was quite popular during the so-called "bicycle days."

The turret has been mounted so as to rotate vertically, horizontally and at an incline.

Fig. 2 represents the circular turret as found on the Brown & Sharpe automatic screw machines and which has the advantage that turret tools when being indexed do not interfere with the cross-slide tools to the extent that the tools do in a turret that is mounted as in Fig. 1.

Fig. 3 represents a modification of type 1 in which the turret is of hexagonal form, having flat faces to which the tools may be bolted in addition to the usual cylindrical holes.

Warner & Swasey have brought out a so-called "hollow hexagon turret," Fig. 4, which has the advantage over the solid type in being much lighter in weight, which is particularly desirable on machines requiring large turrets, and it furthermore permits of the tool holders being clamped by bolts passing through the inner wall.

To C. Conradson is generally given the credit of having brought out the inclined

*Department foreman, Pratt & Whitney Company.

hexagon turret, as shown by Fig. 5. This form is very favorably known in connection with the Gisholt and Herbert turret lathes, and permits of the convenient use of long boring bars and obviates their interfering with the large turnstile or pilot wheel while indexing.

A further modification of the hexagon flat-face turret is that brought out by B. M. W. Hanson, of the Pratt & Whitney Company, and shown by Fig. 6. In this turret are also found the cylindrical holes for holding small turret tools. The dovetailed form of the binding faces permits of clamping box tools, etc., at any desired center distance, and thus makes a machine being known as the Gridley automatic.

A horizontal cylindrical revolving head, Fig. 9, with cylindrical holes in its ends is a design possessing rigidity and is found in the Cleveland automatics.

I have been unable to ascertain who was the originator of the cylindrical type of turret which probably was the earliest design. The flat or disk form of turret was brought out by Everett Horton, of New Haven, Conn., about thirty years ago and patented by him in 1881; U. S. patent No. 247,352. Fig. 10 is a copy of one of the illustrations in this particular patent. While it is not within the province of this type of turret lathe together with an automatic reverse for thread cutting. This turret is shown in Fig. 13.

Still later a design, Fig. 14, was brought out by J. Hartness, U. S. patent No. 457,967, in which are incorporated the features that have made the Jones & Lamson product so well known.

A modified form of the disk turret, Fig. 15, is one of the regular Pratt & Whitney products and was of Hanson's conception, the claims for this form being that the tools when clamped on the tool slot are so well backed up by the projecting uprights on the turret that they are as rigid as though solid with the latter, and that

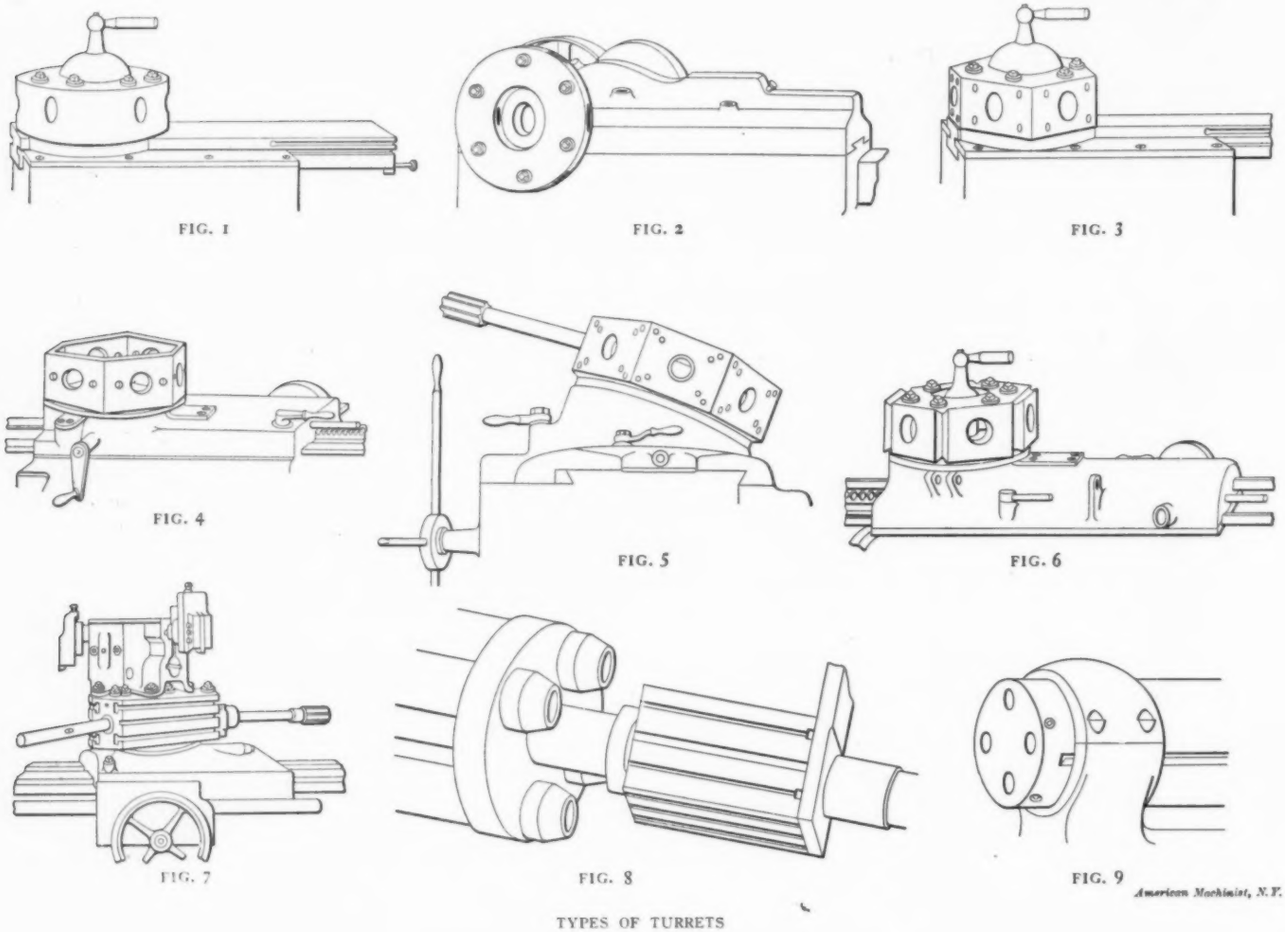


FIG. 1 FIG. 2 FIG. 3

FIG. 4 FIG. 5 FIG. 6

FIG. 7 FIG. 8 FIG. 9

American Machinist, N.Y.

TYPES OF TURRETS

given tool effective for varying diameters of work. A turret binder with a large hole through it, permitting of long work passing through and thus being handled is also a distinctive feature.

A turret extension, or more properly speaking, a double turret with two sets of turret holes and flat faces, as in Fig. 7, is one of the features of the Pond "rigid turret lathe."

In Fig. 8 is shown a square form of turret mounted so as to rotate horizontally. This type has been found in several makes of turret lathes, but to my knowledge a machine with such turret arrangement is only regularly marketed by the Windsor Machine Company, this ma-

article to dwell upon the claims of the various patents, it is interesting to note that the value of an annular clamping gib having generous surface was considered a necessary feature at that time when light cuts were more of the order.

Another Yankee, John Jennings of New London, Conn., patented a modified disk form of turret, having a central turret binder, as shown by Figs. 11 and 12; U. S. patent No. 452,524, dated May 19, 1891. In this construction is also provided means for traversing the turret at right angles to its longitudinal movement.

An Englishman, Charles Leigh Clark, on June 12, 1886, U. S. patent application No. 7879, shows a somewhat similar

when the central turret binder is bound, the turret and slide are solid as a single member.

As stated previously the character of the work that is to be machined should have much to do with the design of the turret. Within the last few years work has been machined on turret lathes by the aid of new types of fixtures that would hardly have been thought applicable to these machines ten years ago. Heavy projectiles, railroad work and automobile parts are now being successfully handled on turret lathes and have been important factors in their development. This work generally being of large dimensions, although not always requiring particularly

heavy cuts, has necessitated the use and design of box tools and turret fixtures proportionately larger than when the machines were used in producing a smaller line of work. The increase in size of these fixtures also made it imperative that the turret be increased in size. To permit of this enlargement without undue increase in weight and in clumsiness and also without sacrificing rigidity to the turret, has been one of the problems for the designer. The index tools which require that there be no projecting stud to interfere with the operation of the tool.

I am in position to be able to bring to the attention of the readers of this paper another Hanson disk type of turret which has the above desirable features. Referring to Fig. 16 it will be seen that the turret, which is of light weight, has an inclosed binder directly under the tool in operation and that this binder does not interfere with the work passing over the disk type of turret that is effective and so placed as to be conveniently operated will be appreciated by the workman.

For special work there have been made some unusual types of revolving tool holders which possess merit. Fig. 17 illustrates a lantern of spindles which is indexed as a whole while during the cutting operation only one spindle is fed forward. This makes a quickly operated device as well as one that is quite sensitive.

It is unwise to suppose that the turret

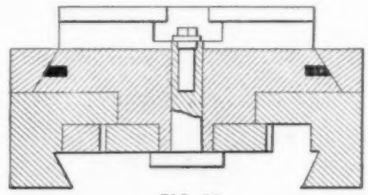


FIG. 10

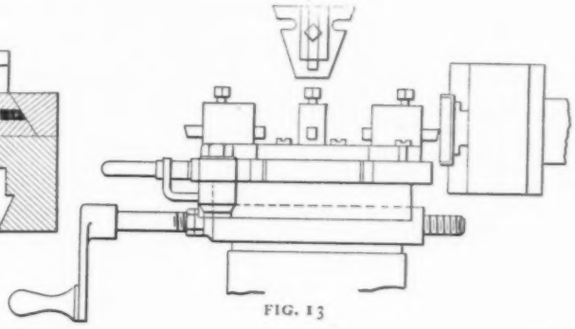


FIG. 13

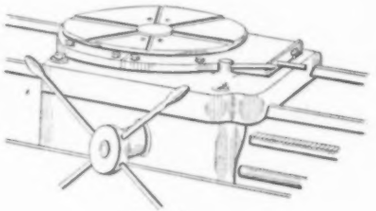


FIG. 14

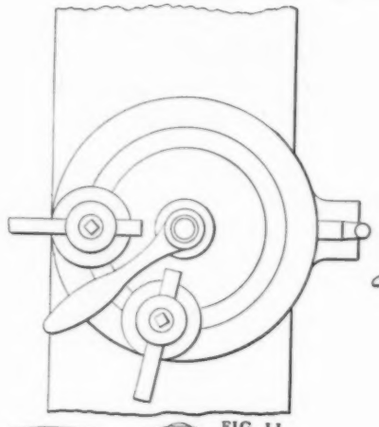


FIG. 11

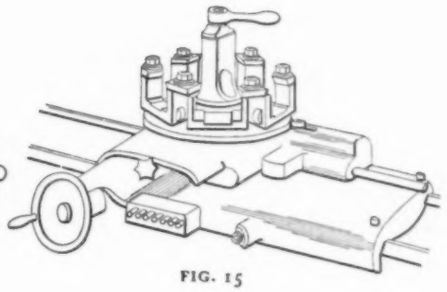


FIG. 15

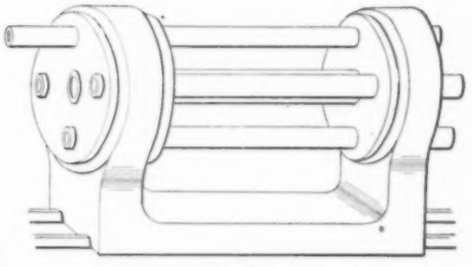


FIG. 17

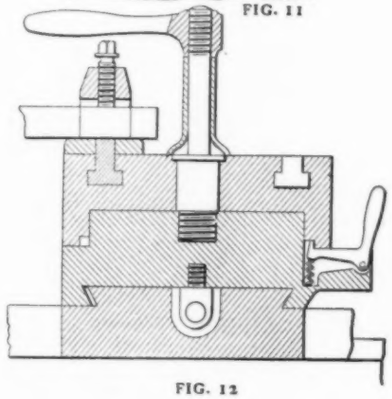


FIG. 12

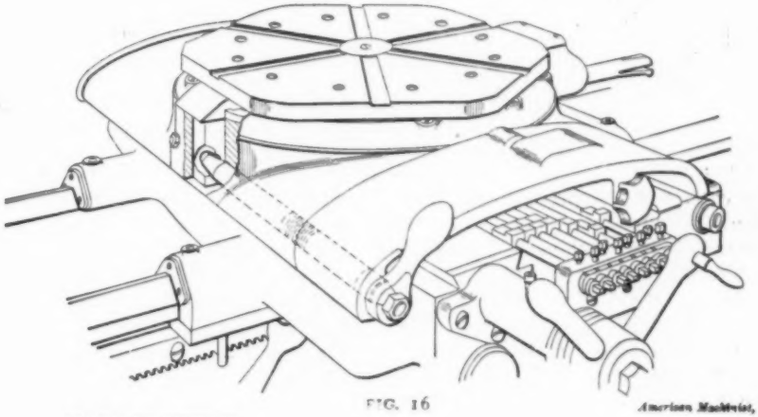


FIG. 16

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TYPES OF TURRETS

or turret lock-bolt device is, of course, of increased radial dimensions and on the enlarged turret is generally positioned close to its outer edge and practically directly under the cutting tool. The usual type of central turret binder which is so effective on the small turrets, however, is less effective on large, light turrets, as the clamping effect is found to be mostly on the inner surface of the turret bearing. Furthermore on the class of work in question it is desirable many times to use top of turret, nor does it prevent tools from being placed at any desired position on its face. This turret has been found to possess unusual rigidity and heavier cuts than formerly possible have been taken. It is exceptionally large in diameter and might be more appropriately termed a turn table; it is of ample dimensions for accommodating elaborate fixtures. In all of the Pratt & Whitney turret lathes there is found some type of turret binder and the retaining of one in the lathe has been fully developed as yet in regard to the type of revolving tool holder, as new lines of work having still different requirements are to be expected, and the mechanic naturally realizes that there will be continued improvements and modifications.

In summarizing it must be acknowledged that all of the forms shown have their valuable features and there is legitimate reason for their use.

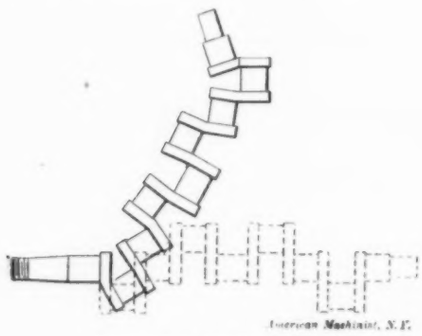
# The Properties of High Tension Steels*

## Results of Experimental Investigations of the Properties of Various Alloy Steels Intended for High Tension and Endurance Purposes

BY PERCY LONGMUIR

The modern high-speed engine has resulted in the introduction of various types of high-tension steels, so termed, in that high tensile properties are demanded by builders. Objection to the term may arise from the fact that steels of high endurance rather than high tensile properties are required. However, as the majority of steels are judged by tension tests, the term is here taken to include endurance as well—i.e., high resistance to the actual conditions of working which are not necessarily limited to tensile stresses.

The ideal steel is one possessing good properties in its normal state, admitting of ready improvement by reasonable treatment, and capable of yielding regular results under ordinary commercial conditions of production and manipulation. In surveying the available field, attention is naturally directed first to nickel steels.



TEST OF A CRANK SHAFT

Experience has shown that these steels have not realized the sanguine expectations entertained some years ago; still, in many directions they serve most useful purposes. The development of alloy steels into which nickel enters as a constituent has led to the introduction of nickel-chromium, nickel-vanadium and chromium-vanadium steels, each type of steel possessing characteristic properties.

Some two years ago a series of experiments was commenced with a view to deciding the most serviceable type of steel for high-tension and endurance purposes. The experimental work has been conducted in coöperation with S. Fox & Co., Limited, Sheffield, and the author's heartiest thanks are tendered to this firm for the many facilities afforded and for permission to publish the results obtained.

*Nickel Steels*—The seventh report to the Alloys Research Committee gives the properties of a series of ascending nickel steels. The commercial members of this series are included in Table I.

This characteristic brittle zone, which appears to vary with the amount of carbon present has been noted in most published investigations, but attention was first drawn to it by Sir Robert Hadfield in 1898 in an exhaustive examination of alloys of iron and nickel low in carbon.

Practice recognizes the necessity of treatment, and experience has shown the safe limits to which nickel may be added to a steel of given carbon content. An ordinary commercial nickel steel, containing 2.95 per cent. of nickel and 0.20 per cent. of carbon, subjected to various forms of treatment, gave the results shown in Table II.

The air-cooled specimens show that, so far as a temperature range of 800 to 950 degrees Centigrade is concerned, very little effect on tensile properties results. Nos. 5 to 8 show that a moderate oil-quenching temperature has also little or no effect on this particular steel, hence the effect of a rising temperature is lost. Water-quenching from 780 degrees Centigrade results in a considerable change, and the effect of a rising temperature is well evidenced. Nos. 12 to 14 are erratic, and while a difference of 90 degrees might possibly account for the difference in elongation between Nos. 12 and 13, it cannot account for the difference in elastic limits. No. 14, in precisely the same condition as No. 13, gives a lower elongation, and is, therefore, included by way of contrast.

A second set of experiments are recorded in Table III, the steel in this case being comparable with the preceding sample—i.e., low carbon, 3 per cent. nickel commercial steel.

With one exception all the elongations are good; however, the elastic limits are low except in the case of No. 22. From the two sets of experiments it is fairly reasonable to conclude that under normal oil-quenching conditions, average properties of a low-carbon steel containing 3 per cent. nickel would be of the following order:

| Elastic Limit. Tons per Square Inch. | Maximum Stress. Tons per Square Inch. | Elongation per Cent. on 2 In. |
|---|---|---|
| 30 | 40 | 24 |

Under exceptional conditions higher values may be obtained, but experience teaches that with an elongation greater than 20 per cent., yield-points exceeding 30 tons are not regularly obtained.

If treated to give a high yield point, a corresponding decrease in elongation follows. It is fairly obvious that a yield point of 30 tons and an elongation of 24 per cent. represents a most useful steel and one valuable for many purposes.

| Content of Nickel Per Cent. | Bending Test. Angle. | Tensile Tests. Yield Point. Tons per Square Inch. | Maximum Stress. Tons per Square Inch. | Elongation per Cent. on 2 Inches. | Reduction of Area per Cent. | Torsion Test. Twisting Moment. Inch-Lb. | Angle of Twist at Fracture. |
|---|---|---|---|---|---|---|---|
| nil | 180 degrees, unbroken | 21 | 38.19 | 25 | 51.73 | 4277 | |
| 1.20 | 180 degrees, unbroken | 23.93 | 40.93 | 21 | 42.80 | 5077 | 405 |
| 2.15 | 180 degrees, unbroken | 23.67 | 41.52 | 24.5 | 51.83 | 5609 | 621 |
| 4.25 | 180 degrees, unbroken | 29.16 | 47.86 | 20 | 33.06 | 5071 | 468 |
| 4.95 | 30 degrees, broken | 33.95 | 60.09 | 2 | 3.71 | 6429 | 177 |

TABLE I.

Average high-tension requirements are of the following order:

| | |
|---|---|
| Elastic limit | 40 tons per square inch |
| Maximum stress | 50 tons per square inch |
| Elongation | 20 per cent. on 2 inches |

Greater values are sometimes specified, but the foregoing represent average and more rational requirements. Higher nickel steels are more successful in meeting two of these requirements, and a few results obtained from a 5 per cent. nickel steel of low carbon are included in Table IV.

From an all-round point of view it is evident that this steel is in its best condition in the normalized state, as in No. 24. Elastic limit and maximum stress are high in the treated state, but elongations are low. In this respect Nos. 28 and 29 are peculiar in the low elongation accompanying the lower quenching temperatures. After treating the steels are readily machined, a remark also applicable to water quenched samples. However, water-quenching in this case resulted in the development of cracks.

*A paper presented before the British Iron and Steel Institute.

It is possible that by special treatment higher elongations may be obtained, but under ordinary conditions values of 20 per cent. are not easily attainable. Therefore, the higher nickel steels, while valuable in certain directions, are not applicable where high tensile strength associated with high elongation is required.

*Nickel-chromium Steels*—Nickel steels stiffened by small amounts of chromium find various applications in practice. These steels readily admit of oil or water quenching, and, further, admit of considerable stiffening by air quenching. Some interesting results have been published by Guillet, and the following values are taken from his paper read before this Institute:

Steel containing carbon from 0.25 to 0.45 per cent., nickel from 2.5 to 2.75 per cent., and chromium from 0.275 to 0.60 per cent. gives:

| No. | Treatment. | Elastic Limit. | Maximum Stress. | Elongation per Cent. on 2 Inches. | Reduction of Area per Cent. |
|---|---|---|---|---|---|
| | | Tons per Square Inch. | Tons per Square Inch. | | |
| 1 | As received | 26.91 | 40.19 | 29 | 56.3 |
| 2 | Air-cooled from 800 degrees C. | 29.04 | 39.10 | 30 | 58.3 |
| 3 | Air-cooled from 900 degrees C. | 27.50 | 39.20 | 30.5 | 55.9 |
| 4 | Air-cooled from 950 degrees C. | 29.58 | 39.17 | 27.5 | 56.6 |
| 5 | Quenched in oil from 760 degrees C., tempered 435 degrees | 28.52 | 41.91 | 27 | 59.3 |
| 6 | Quenched in oil from 760 degrees C., tempered 530 degrees | 31.90 | 43.76 | 27.5 | 57.2 |
| 7 | Quenched in oil from 760 degrees C., tempered 630 degrees | 32.43 | 43.07 | 28.5 | 59.1 |
| 8 | Quenched in oil from 760 degrees C., tempered 670 degrees | 31.41 | 41.14 | 28 | 59.1 |
| 9 | Quenched in water from 780 degrees C., tempered 420 degrees | 69.88 | 77.95 | 10 | 42.1 |
| 10 | Quenched in water from 780 degrees C., tempered 600 degrees | 50.89 | 55.91 | 17.5 | 57.9 |
| 11 | Quenched in water from 780 degrees C., tempered 660 degrees | 37.64 | 47.68 | 21.5 | 54.1 |
| 12 | Quenched in water from 920 degrees C., tempered 460 degrees | 51.53 | 60.12 | 10.5 | 26.6 |
| 13 | Quenched in water from 920 degrees C., tempered 550 degrees | 60.61 | 63.84 | 19.5 | 51.1 |
| 14 | Quenched in water from 920 degrees C., tempered 550 degrees | 59.93 | 61.98 | 15 | 53.4 |

TABLE II. 2.95 PER CENT. NICKEL STEEL.

| Condition. | Elastic Limit. | Maximum Stress. | Elongation per Cent. on 2 Inches. |
|---|---|---|---|
| | Tons per Square Inch. | Tons per Square Inch. | |
| Annealed 900 degrees C. and slowly cooled | 22.5 to 31.75 | 35 to 47.5 | 15 to 25 |
| Quenched 850 degrees C., reheated to 350 degrees | 38 to 63.5 | 50.75 to 70 | 8 to 12 |

Steel containing carbon 0.25 to 0.45 per cent., nickel 5 to 6 per cent., and chromium 0.5 to 1 per cent. gives:

| Condition. | Elastic Limit. | Maximum Stress. | Elongation per Cent. on 2 Inches. |
|---|---|---|---|
| | Tons per Square Inch. | Tons per Square Inch. | |
| Annealed 900 degrees C., and slowly cooled | 35 to 47.5 | 41.75 to 55.25 | 20 to 25 |
| Quenched in water, not reheated | 41.5 to 70 | 50.75 to 79.5 | 11 to 18 |

As an illustration of the high values obtainable from nickel-chromium steels the tests given in Table V from commercial forgings are quoted.

Nos. 30 to 36 represent a steel containing 0.30 per cent. of carbon, 5 per cent. of nickel, and 1 per cent. of chromium. No. 37 contains 0.40 per cent. of carbon, 3 per cent. of nickel, and 0.5 per cent. of chromium.

The results show a considerable advance on simple nickel steel, and the characteristic features are high elastic limits and maximum stress, with fair elongation. Under ordinary conditions 20 per cent. elongation can rarely be exceeded when treated for high yield point and maximum stress. Under these conditions the difficulty lies in approaching 20 per cent. elongation, and, as a rule, it is safer to take 15 per cent. as a normal average value.

Treated nickel-chromium steels are machinable, but not freely so, and greater difficulty is encountered than with treated nickel steel.

*Vanadium Steels*—The literature of vanadium steel is fairly rich, and during the last year or so many favorable articles have appeared in various technical journals. The first definite results were obtained by Arnold, and privately published. Some of these results, quoted by Harbord, show extremely high tensile values.

Sankey and Kent Smith have investigated the heat treatment of chromium-vanadium steels, and their results are of considerable importance. Possibly one of the most valuable features shown by these investigators is the high resistance of the steel under dynamic tests. This feature is well exemplified in the results obtained by Arnold's alternating stress test and Izod's pendulum impact test. In the treated state tensile values are notably high; this, in conjunction with high alternating and impact values, renders the steel of considerable value. By way of illustration the following result from Sankey and Kent Smith's paper may be quoted:

| [No.] | Treatment. | Elastic Limit. Tons. | Maximum Stress. Tons. | Elongation per Cent. on 2 Inches. | Reduction of Area per Cent. | Izod Impact Test Pool-Lb. Average. | Arnold Alternating. No. of Alternations. |
|---|---|---|---|---|---|---|---|
| 24 | Oil-quenched at 900 degrees C.; reheated to 600 degrees C. | 43.4 | 53.6 | 22 | 56.6 | 13.4 | 1938 |

These values are exceptionally good, and provided similar results could be regularly obtained in practice, the steel would obviously approach the ideal.

Various types of vanadium steel have been investigated from the point of (1) production and (2) treatment under commercial conditions. The types included nickel vanadium and chromium vanadium, the latter series proving the best all-round steels as judged by ordinary commercial standards. A triple chromium-nickel-vanadium steel would, under certain conditions, prove of value in structural work.

A few preliminary experiments are embodied in Table VI.

The results recorded are obtained from an experimental steel containing only 0.40 per cent. of chromium and 0.18 per cent. of vanadium. In view of the low percentage of special elements, the values are decidedly good. Naturally a higher percentage of chromium gives better values, and although the preliminary work led to the recognition of several types of commercial chromium-vanadium steels, the type coming within the category of this paper contains

| | Per Cent. |
|---|---|
| Carbon | 0.35 |
| Chromium | 1 |
| Vanadium | 0.20 |

with sulphur and phosphorus, each below 0.035 per cent.

The tests recorded in Table VII are from two separate casts of open-hearth steel, produced under the ordinary conditions of practice, in charges of 15 and 20 tons, respectively. The object is to give tests from the billets and various sizes of bars from each cast.

Nos. 46 and 51, representing rough billets on which very little work has been

put, are very striking; No. 47, giving an elongation of 34 per cent., and an elastic limit of 46 tons per square inch, is especially noteworthy. Another length of this bar, after bending parallel, was flattened together in the cold by blows from a 5-ton hammer without developing any sign of flaw. The elongation values of Table VII are of special interest when compared with the values given under "Elastic Limit."

Test bars from treated cranks and axles yield high values, corresponding to those recorded in Table V. A few typical results are given in Table VIII.

The steel represented in this table contained 0.32 per cent. of carbon, 1.10 per cent. of chromium, and 0.16 per cent. of vanadium, and the treatment—water quenching from 900 degrees Centigrade, followed by moderate tempering—is designed to give high yield point and maximum stress. A number of tests from actual forgings treated as above give values between Nos. 56 and 59. This section of the work showed that a chromium-vanadium steel of the foregoing type will yield values quite equal to those of a 5 per cent. nickel and 1 per cent. chromium steel.

The most noteworthy feature of chromium vanadium steel is its "endurance," and the progress of the work has shown that with no special treatment exceptionally good results are regularly obtained, as in Table VII. When treatment is desired, the most intricate forgings are readily and effectively dealt with by oil quenching. A quenching range of from 850 degrees to 900 degrees Centigrade and a tempering range of from 500 to 600 degrees Centigrade yield excellent results. With this treatment resulting values exceed:

Elastic limit.....40 tons per square inch
Maximum stress.....50 tons per square inch
Elongation.....20 per cent. on 2 inches
Reduction of area.....45 per cent.

In addition, excellent bending, torsion, impact and alternating values are obtained. It is not proposed to quote a series of tests, but to take the following concrete case. Two cranks treated as shown in the tables were cut up into various test pieces; the values obtained, therefore, represent the crank, and not test pieces attached to it.

A higher water-quenching temperature would have given values of the order shown in Table VIII. In reference to hardness, each value reported represents the average of six determinations taken along the surface and across the section. In each case bending test bars bend through an angle of 180 degrees and may be afterward hammered together without producing fracture. A comparison of the tensile, torsional, and hardness values of Table IX is of considerable interest to crank manufacturers.

As a contrast to the foregoing some tests from nickel cranks are included in Table X.

| No. | Treatment. | Elastic Limit. | Maximum Stress. | Elongation per Cent on 2 Inches. | Reduction of Area per Cent. |
|---|---|---|---|---|---|
| | | Tons per Square Inch. | Tons per Square Inch. | | |
| 15 | As received | 29.2 | 38.60 | 23.5 | 54.8 |
| 16 | Air-cooled from 800 degrees C. | 24.5 | 34.32 | 30 | 57.2 |
| 17 | Heated to 1000 degrees C., oil-quenched at 1000 degrees C., tempered at 490 degrees. | 34 | 44.40 | 25 | 61.6 |
| 18 | Heated to 1000 degrees C., oil-quenched at. 1000 degrees C., tempered at 490 degrees.. | 29.6 | 42.52 | 26 | 63.2 |
| 19 | Heated to 1000 degrees C., oil-quenched at 900 degrees C., tempered at 490 degrees.. | 33.2 | 44.20 | 22.5 | 64 |
| 20 | Heated to 1000 degrees C., oil-quenched at 750 degrees C., tempered at 490 degrees.. | 30 | 42 | 26 | 63.2 |
| 21 | Heated to 800 degrees C., oil-quenched at 800 degrees C., tempered at 490 degrees..... | 28.4 | 41.24 | 28 | 64 |
| 22 | Heated to 1000 degrees C., oil-quenched at 1000 degrees C., tempered at 490 degrees. | 43.2 | 50.60 | 15.5 | 50 |

TABLE III. 3 PER CENT. NICKEL STEEL.

| No. | Treatment. | Elastic Limit. | Maximum Stress. | Elongation per Cent. on 2 Inches. | Reduction of Area per Cent. |
|---|---|---|---|---|---|
| | | Tons per Square Inch. | Tons per Square Inch. | | |
| 23 | As received | 47.6 | 56.96 | 13.5 | 20 |
| 24 | Air-cooled from 800 degrees C. | 34.8 | 49.08 | 18 | 38 |
| 25 | Heated to 1000 degrees C., quenched in oil at 1000 degrees C., tempered at 490 degrees. | 64.8 | 76.00 | 12.5 | 43.6 |
| 26 | Heated to 1000 degrees C., quenched in oil at 1000 degrees C., tempered at 490 degrees. | 68.4 | 70.92 | 10 | 37.6 |
| 27 | Heated to 1000 degrees C., quenched in oil at 900 degrees C., tempered at 490 degrees.. | 66.8 | 70.08 | 12.5 | 45.2 |
| 28 | Heated to 1000 degrees C., quenched in oil at 750 degrees C., tempered at 490 degrees.. | Not detected | 82.56 | 1.5 | 0.4 |
| 29 | Heated to 800 degrees C., quenched in oil at 800 degrees C., tempered at 490 degrees.. | 65.2 | 78.40 | 0.3 | 2.5 |

TABLE IV. 5 PER CENT. NICKEL STEEL.

| No. | Condition. | Elastic Limit. | Maximum Stress. | Elongation per Cent. on 2 Inches. | Reduction of Area per Cent. |
|---|---|---|---|---|---|
| | | Tons per Square Inch. | Tons per Square Inch. | | |
| 30 | Annealed | 28.8 | 44.8 | 25 | 50 |
| 31 | Treated, *i.e.*, quenched in water from 850 degrees C. to 900 degrees C., and tempered at 550 degrees C. | 58.48 | 63.84 | 16 | 38.6 |
| 32 | | 59.63 | 66.23 | 16 | 38.6 |
| 33 | | 52.42 | 61.16 | 18 | 41.6 |
| 34 | | 59.74 | 64.28 | 19.5 | 47.2 |
| 35 | | 56.70 | 63.66 | 20 | 43.4 |
| 36 | | 55.08 | 61.88 | 21 | 45.4 |
| 37 | | 40 | 55 | 18 | 46 |

TABLE V. NICKEL-CHROMIUM STEELS.

| No. | Treatment. | Elastic Limit. | Maximum Stress. | Elongation per Cent. on 2 Inches. | Reduction of Area per Cent. |
|---|---|---|---|---|---|
| | | Tons per Square Inch. | Tons per Square Inch. | | |
| 38 | Air-cooled from 800 degrees C. | 27.28 | 40.51 | 27.5 | 57.5 |
| 39 | Quenched from 920 degrees C. in water, tempered at 550 degrees | 58.08 | 66.22 | 14.5 | 48 |
| 40 | Quenched from 900 degrees C. in water, tempered at 550 degrees | 47.62 | 55.01 | 19.5 | 57 |
| 41 | Quenched from 760 degrees C. in water, tempered at 550 degrees | 40.51 | 52.09 | 23.5 | 57.9 |
| 42 | Quenched from 800 degrees C. in oil, tempered at 460 degrees | 43.92 | 52.29 | 20 | 48.4 |
| 43 | Quenched from 920 degrees C. in oil at 100 degrees C. (not tempered) | 35.55 | 46.25 | 21 | 55.1 |
| 44 | Quenched from 900 degrees C. in oil at 100 degrees C. (not tempered) | 33.37 | 44.53 | 22.5 | 56.3 |
| 45 | Quenched from 760 degrees C. in oil at 100 degrees C. (not tempered) | 30.37 | 41.21 | 29.5 | 60.5 |

TABLE VI. CHROMIUM-VANADIUM STEELS.

| No. | Condition. | Elastic Limit. | Maximum Stress | Elongation per Cent. on 2 Inches. | Reduction of Area per Cent. |
|---|---|---|---|---|---|
| | | Tons per Square Inch. | Tons per Square Inch. | | |
| 46 | Piece cut from cogged billet | 32 | 47.4 | 24 | 48 |
| 47 | 1-in diameter rolled bar | 46.04 | 57.13 | 34 | 51.1 |
| 48 | 1½-inch diameter rolled bar | 39.58 | 55.02 | 25.5 | |
| 49 | 3-inch diameter hammered bar | 38.58 | 48.92 | 20.5 | |
| 50 | 4-inch diameter hammered bar | 37.06 | 50.90 | 25 | |
| 51 | Piece cut from cogged billet | 34.8 | 50.10 | 23.5 | 34.8 |
| 52 | ¾-inch diameter rolled bar | 46.78 | 64.38 | 27 | 52.6 |
| 53 | 1-inch diameter rolled bar | 41.34 | 52.42 | 28 | 55.8 |
| 54 | 2-inch diameter rolled bar | 40.08 | 54.08 | 22.5 | 43.4 |
| 55 | 2½-inch diameter rolled bar | 37.06 | 49.74 | 20.5 | 33.6 |

TABLE VII. CHROMIUM-VANADIUM STEEL BARS.

The two cranks represented in the above tests are of typical commercial nickel steel, and on the whole give very satisfactory tensile tests; however, the torsion tests are anything but good. The working life of these cranks is in the case of A a mileage of 41,356, and in the case of B a mileage of 39,523 on a British railway. It will be noted that these figures are considerably below those usual with ordinary wrought-iron cranks.

A comparison of Tables IX and X shows distinctly in favor of chromium-vanadium steel as judged by tensile and torsion tests. Experience gained during the progress of this work clearly shows that for all-round properties chromium-vanadium steel is excellent. While individual tests always give good results, it is the combination of properties which denotes the special virtues of this steel.

Sankey and Kent Smith, in the paper already quoted, have shown the high values obtained from chromium-vanadium steels in the Arnold alternating stress test and in the Izod pendulum impact test. In the present work test pieces cut from commercial forgings have given Izod impact values of from 9 to 15 foot-pounds. Rotating alternating stress tests have also given good results, and extremely high values have been obtained from the Stead alternate bending test.

A series of comparatively rough tests have been made; for example, treated axles 1½ inches in diameter, giving yield points of 45 tons per square inch and elongations of 20 per cent. or over, will bend parallel, and then hammer close without developing flaws. This test is severe, and has to be effected by blows from a 5-ton hammer, and after each blow the resilience of the steel is shown in a perceptible return of the axle. The illustration shows another type of test of a finished hollow crank.

The crank was gripped at one end under a 5-ton hammer, a bar inserted in the free end and attached to a steam crane. Difficulty was met in obtaining any permanent bending; for example, after lifting the free end of the crank about 6 inches, releasing the lifting moment resulted in a return to the original position. Finally, the bend shown was obtained, and the point of fracture in which most of the stresses were first felt is indicated. It should be added that this particular crank was forged from the top billet of an ingot, and contained a very visible pipe. In other words, the crank was made from steel which in the ordinary course is cropped and scrapped. Tests of this kind give the author considerable faith in treated chromium-vanadium steel. With suitable manipulation more picturesque results are obtained, but Fig. 1 is given as an example of a rough and severe test.

The tests recorded in the foregoing are all from commercial steels, and no abnormal values are given. The object has been to group up typical tests of high-tension steels, and naturally only a portion of the ground covered can be dealt with in a short paper.

The work done shows that nickel steels do not give the high values obtained from nickel chromium or chromium vanadium. The last two represent exceptionally good types of high-tension steels, but for all-round properties chromium vanadium gives the best results. At the moment vanadium is attracting much attention, but the only point from which it has been considered in this paper is that of applicability as a structural steel. The results amply confirm previous work in this direction, and go to show that a remarkable range of properties may be obtained by suitable manipulation in conjunction with a moderate percentage of chromium. The value of the steel as a constructive material in the case of high-speed engines is evident.

| No. | Test Cut From | Elastic Limit. | Maximum Stress. | Elongation per Cent. on 2 Inches. | Reduction of Area per Cent. |
|---|---|---|---|---|---|
| | | Tons per Square Inch. | Tons per Square Inch. | | |
| 56 | 1-inch diameter bar | 63.48 | 67.68 | 17 | |
| 57 | Crank | 56.44 | 64.78 | 15 | |
| 58 | Axle | 61.34 | 67.32 | 17 | 33.6 |
| 59 | Axle | 56.16 | 63.12 | 22 | 47.2 |

TABLE VIII. TREATED CHROMIUM-VANADIUM STEELS.

| No. | Treatment. | Elastic Limit. | Maximum Stress. | Elongation per Cent. on 2 Inches. | Reduction of Area per Cent. |
|---|---|---|---|---|---|
| | | Tons per Square Inch. | Tons per Square Inch. | | |
| 60 | Quenched from 800 degrees C. in water, tempered 545 degrees C | 38.84 | 49.08 | 21 | 49.6 |
| 61 | Quenched from 800 degrees C. in water, tempered 545 degrees C | 39.36 | 49.44 | 21.5 | 52.4 |
| 62 | Quenched from 900 degrees C. in oil, tempered 545 degrees C | 49 | 56.52 | 21 | 56 |
| 63 | Quenched from 900 degrees C. in oil, tempered 545 degrees C | 44.56 | 56.40 | 23 | 56.8 |

TENSILE TESTS.

| No. | Treatment. | Calculated Shearing. Maximum Stress. | Final Twist. | |
|---|---|---|---|---|
| | | | Angle. | No. of Twists. |
| | | Tons per Square Inch. | | |
| 64 | Quenched from 800 degrees C. in water, tempered 545 degrees C | 44.7 | 1174 | 3.26 |
| 65 | Quenched from 900 degrees C. in oil, tempered 545 degrees C | 53.7 | 1156 | 3.21 |

TORSION TESTS.

| No. | Treatment. | Position. | Brinell's Hardness No. |
|---|---|---|---|
| 66 | Quenched from 800 degrees C. in water, tempered 545 degrees C | Outer surface | 210 |
| 67 | Quenched from 800 degrees C. in water, tempered 545 degrees C | Cross-section, internal | 218 |
| 68 | Quenched from 900 degrees C. in oil, tempered 545 degrees C | Outer surface, | 246 |
| 69 | Quenched from 900 degrees C. in oil, tempered 545 degrees C | Cross-section, internal | 255 |

HARDNESS DETERMINATIONS.

| Carbon. Per Cent. | Manganese. Per Cent. | Chromium. Per Cent. | Vanadium. Per Cent. |
|---|---|---|---|
| 0.32 | 0.45 | 1.10 | 0.16 |

ANALYSIS.

TABLE IX. CHROMIUM-VANADIUM-STEEL CRANKS. TENSILE TESTS.

| No. | Nickel. | Maximum Stress. | Elongation per Cent. on 2 Inches. | Reduction of Area. |
|---|---|---|---|---|
| | Per Cent. | Tons per Square Inch. | | Per Cent. |
| 70 A | 3.22 | 41.90 | 27.4 | 46.7 |
| 71 B | 3.42 | 31.80 | 37.9 | 52.4 |

TENSILE TESTS.

| No. | Nickel. | Maximum Stress. | Final Twist. Angle. |
|---|---|---|---|
| | Per Cent. | Tons per Square Inch. | Degrees. |
| 72 A | 3.22 | 10.3 | 493 |
| 73 B | 3.42 | 8.6 | 540 |

TORSION TESTS.

| No. | Nickel. | Test-Bar. | Tons at Centre. | Angle of Bend. |
|---|---|---|---|---|
| | Per Cent. | Square Inch. | Per Cent. | Degrees. |
| 74 A | 3.22 | 1¼ | 20 | 70 |
| 75 B | 3.42 | 1¼ | 14.9 | 90 |

BENDING TESTS.

TABLE X. NICKEL-STEEL CRANKS.

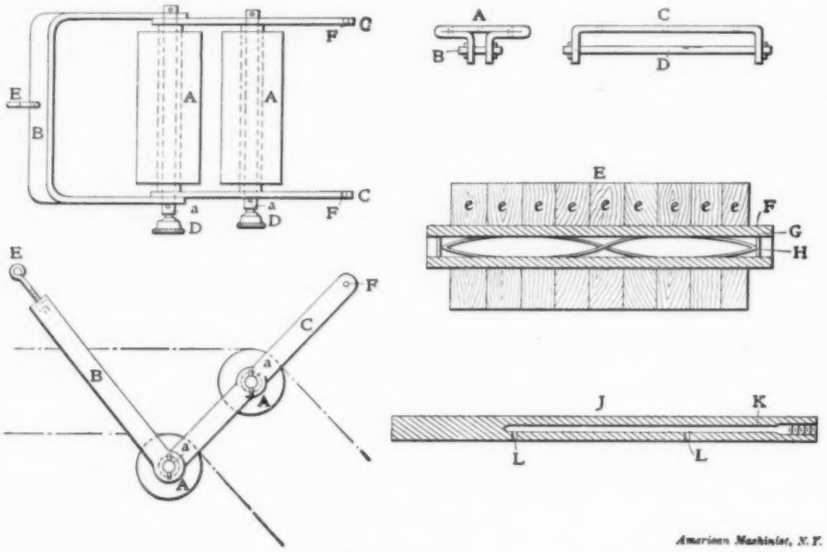
# Practical Letters from Our Readers

## A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

## WE PAY FOR USEFUL IDEAS

### A Special Idler

In the small shop in which I am at present employed the main driving belt was found to be decidedly in the way, running, as it did, at an angle across a door with only a small space between it and the door. I had orders to get it up out of the way.




A SPECIAL IDLER

The engine was in the basement and the ceiling was low, so a countershaft would have been awkward and the drive too short. I decided to rig up some sort of idler which I did with every success.

In Fig. 1 *A A* are the pulleys and *a a* the shafts. *B* is one part of the frame, made in one piece, with the eye bolt *E* passing through the top for adjustment. *C* is the other part of the frame with holes *F*, through which the rod *D* in bracket *C*, Fig. 2, passes. The bracket *C*, Fig. 2, is fixed to the roof with lag screws as is also bracket *A*, with the rod *B* which passes through the eye bolt *I*, Fig. 1. *d d*, Fig. 1 are grease cups.

In making the pulley *E*, Fig. 2, I took some pieces of pine board *e e e*, which I cut to about size. I then bored the hole in the center a tight fit for the piece of 1½-inch pipe *F*. These pieces were put together on the pipe and nailed, the grain of each piece crossing the grain of its neighbor. I then got a block of wood, bored a shallow hole in it to fit the 1½-inch pipe *F*. In the center of this hole I bored a 1-inch hole right through, the block being 4 inches thick. In the 1-inch hole I placed a piece of 1-inch shafting, then I placed one end of the pipe which came through my rough pulley in the shallow hole, centered the shaft at the top end in the pipe and poured the babbitt *G*. To get the oil groove *H* I wound a piece of thick cord tightly around the piece of shaft which formed my babbitting arbor. After winding I hammered it all over to make it lie flat on the shaft and in places where it crossed I put a little putty. Turning over the top finished the pulleys. *J* shows the shafts on which the pulleys run and the method of lubricating. I drilled a hole in the end and tapped it for a grease cup, then the smaller hole *K* was drilled about two-thirds of the length. *L L* are two outlet holes which are on the underside when the shaft is in position.

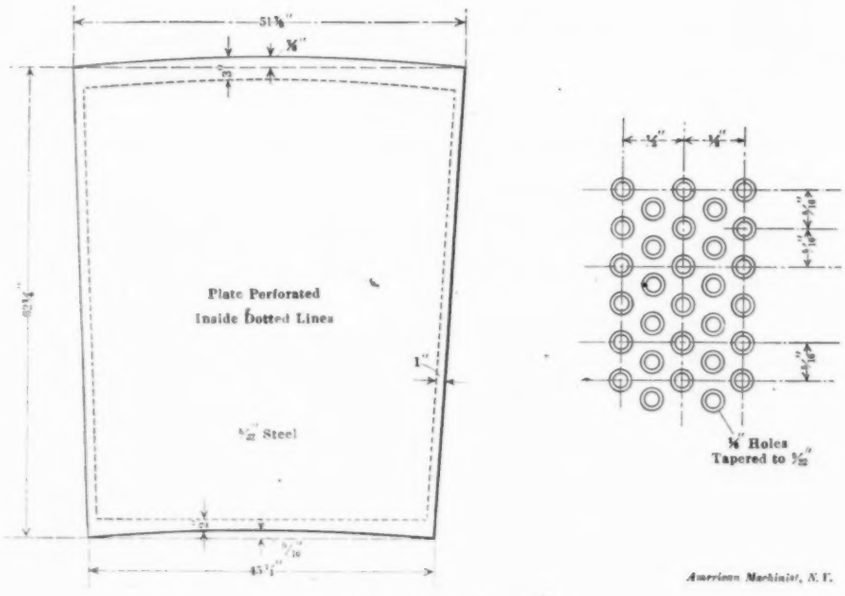
Brockville, Ont. A. G. SCOTT.

### How Would You Produce These Tapered Holes in One Operation?

I would be very thankful if some of the readers could enlighten me on the following subject:

Recently we had a machine to build which which required as a strainer a conical shell of ⅛-inch steel plate 54x56 inches (as shown in the cut), perforated with ⅛-inch holes tapering to 5/32 inch on one side, and after being perforated, rolled to the required diameter.

We tried punching the ⅛-inch hole first with a gang of nine punches and then wedging the taper, but the plate buckles so that it is almost impossible to do anything with it.



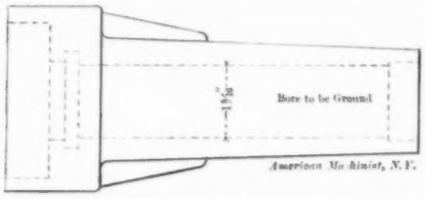

THE PLATE AND THE HOLES

We thought of punching first and reaming the taper after, but upon seeing one from Germany, it looks as though the hole was completed at one operation, no buckling being perceptible, and the spacing very symmetrical.

Marquette, Mich. L. S. F.

## Grinding and Lapping in the Black Country

He walked into the factory one day with a brown-paper parcel under his arm containing a casting of an axle box of an ordinary horse-drawn vehicle, and explained that he ran a small shop and was engaged in the making of these things in the Black country district. Some further chat with him disclosed the fact that he was thinking of putting in some new equipment. Having heard so much of time- and labor-saving machinery generally and the wonderful things now being done, it seemed to him that he would have to hustle around or his neighbors engaged




AXLE BOX FOR ROAD VEHICLE

in the trade might possibly get in front of him. Also, having heard and read much about grinding machines, he thought it likely that he would be doing the correct thing and saving money if he put in a machine for grinding the bore of his axle boxes, which were made of chilled gray iron; he had brought a sample box and wished to have it ground so that he might take note of the time and kind of job produced.

The sample box was approximately of the shape and size given in the sketch, being a beautiful sample of iron founding, and the bore was chilled, leaving 1/32 inch to be removed by grinding. While the Old Man took him out to lunch, the box was chucked in a universal grinding machine and special efforts were made as to time. A wheel, or rather three wheels, were used, these being Norton wheels of 46 grit, grade J; the hole was ground to gage in 43 minutes, and the grinder felt somewhat satisfied with himself and inclined to think he had done well. However, when the prospective customer returned he examined the hole and was pleased with it, but when told of the time taken he said that the rate of production together with the price of the machine would quickly mean bankruptcy to him; he was questioned as to how he machined them and he spoke of his boys lapping them in 20 minutes each with the common lead lap and an antediluvian lathe. Of course, we were all incredulous, and he left us with the impression that he had been talking through his hat. Some two years afterward this same manufacturer put in a 10x50-inch Norton plain grinder with which to grind the ends of his case-hardened axles; incidentally it should be said that he had previously turned them to size and merely polished them after hardening, but the trouble due to their swelling and getting out of shape in hardening had induced him to purchase the grinding machine, and good and quick work was done on it, the time per axle averaging some 3½ minutes. I had occasion to visit the factory in connection with this machine, and in the course of the day referred to the incident already related. After some little banter I was taken to see the lapping operation performed and was shown a sight that Chordal could best describe. Down in the basement were some five or six lathes of an ancient pattern, with their operators reeking with oil and arms bared to the shoulders. Between the centers was a common lead lap cast on a square bar, and beneath the lap was a long trough filled with oil and grit and with a scoop made from a waste piece of tin lying in it. The operator held the box on the lap by means of a lever of a shape to fit the lugs and passed it rapidly backward and forward; every few seconds he fed the lap with his scoop and occasionally he would let the lever rest on the lathe bed and fatten the middle of the lap with a hammer. The time for lapping a hole (removing 1/32 inch) was, respectively, for two boxes 18 minutes and 24 minutes. Several of them were examined and carefully tested and in no case was there more than 0.0015 of bellmouth.

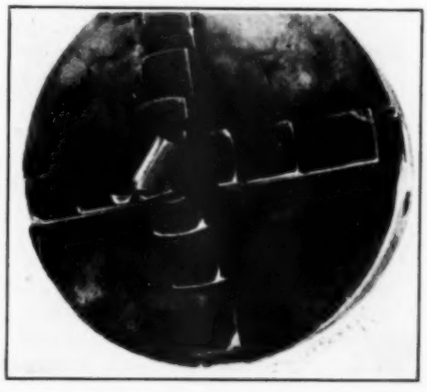
Some few months ago I was in Russia at a factory where an elaborate plant had been put in for doing this same work. Here the bores were not chilled, and expensive turret lathes had been provided for boring and reaming them; wages were also about double those paid in the Black country.

This sets one wondering if this may be one of many instances where the old country still keeps her end up with her foreign competition.

Coventry, England. H. D.

## An Emergency Two Jaw Chuck

Often one needs the two-jaw chuck, when in use by others. This difficulty can be overcome without loss of time by us-



AN EMERGENCY TWO-JAW CHUCK

ing two pieces of angle iron about three inches long. The size of angle depends on the stock you wish to hold. Place the angles in the chuck as shown in illustration.

Quincy, Ill. N. M. P.

## Thread Gages for Screw Machine Work

The great quantities of small screws and tapped pieces used in the manufacture of typewriters, firearms, adding machines, etc., call for the use of gages which will insure the interchangeability of the parts and give assurance that the articles will assemble properly with parts taken from

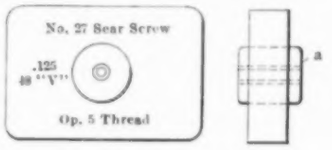



FIG. 1

FIG. 2. THREAD GAGES FOR SCREW-MACHINE WORK

stock, without the necessity of fitting. Many concerns making such parts on the Nos. 00 and 0 Brown & Sharpe automatic screw machine, have in use gages of the solid or non-limit type shown herewith:

Fig. 1 shows a female or templet gage of the solid type made by pressing the button *a* into the flat plate, on which is stamped the part number, operation name and number and the size and pitch of thread.

These buttons are made up in quantities of 12 or more at a time and the gages in use are tested every Saturday, with master plugs kept for this purpose, when those which have become worn are replaced by new ones.

Fig. 2 shows a thread plug gage in which the handle is made separate from the plug, and which is held together by the clamping action of the screw *s*, this method of holding the plug being in the nature of a safety valve, for the screw can be adjusted so as to permit the plug to turn in the handle when too much pressure is applied, thus preventing the breaking of the plug.

Both handles and plug blanks can be made up on the screw machine and carried in stock and the handles when once completed can be used indefinitely while the plugs are carried on hand in the manner of the female gages, permitting the renewal at once when necessary.

All female gages are made by tapping out the buttons with master taps kept especially for this purpose, and after being pack-hardened are lapped out to correct any slight changes developed in hardening. The plug gages are all finished in an ac-

curate lathe which is fitted with a very accurate lead screw and used only for this work.

While the fact is evident that there should be some limit allowed and that this limit should be represented by the sizes of the gages, the taps and dies used and the action of the screw machines are so nearly perfect that no trouble is experienced in producing work to gage.

Springfield, Mass. F. L. GAGER.

## An Adjustable T-Wrench

On my last visit to Blaysdell's shop I noticed him using a little tool of his own devising, which would seem to be of sufficient novelty and interest to warrant a description. It is an instantly automatically adjustable T-wrench, with a vise-like grip.

Fig. 1 is a side view of the tool nearly closed, with one of the side plates *E* removed in order to show the working parts. Fig. 2 is an edge view of the same. Fig. 3 is a side view, same as Fig. 1, except that the jaws are open. In all the Figs. similar letters of reference refer to similar parts.

*A* is a T-shaped handle with the longer arm forming the springs *G G*. The ends of these springs engage in the jaws *C C*. *E* is one of two side plates which extend to, and form part of, the handle *B B*. Fixed between these plates are the rollers *F F*, the guide block *H*, and two fillers

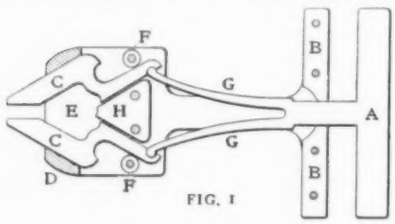


FIG. 1

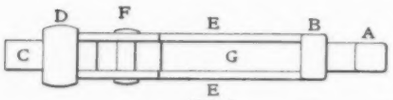


FIG. 2

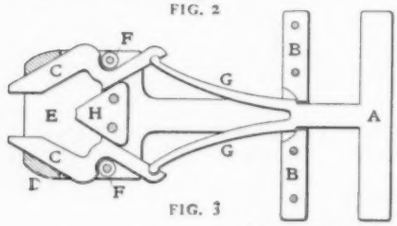


FIG. 3

American Machinist, N.Y.

AN ADJUSTABLE T-WRENCH

which serve, with the side plates *E* to make the handle *B*. Working slidably between the plates are the jaws *C C* and the springs *G G*, which constitute the longer branch of the handle *A*.

The jaws are normally held open, as in Fig. 3, by the springs *G G*. When it is desired to grip a nut or other object, the handles *A* and *B* are grasped with the fingers astride the shank. Drawing the handles *A* and *B* together by closure of the hand, forces the jaws outward, through the band *D*, thus drawing them together and gripping the nut. When the nut is tightly gripped the friction of the jaws on the band *D* is sufficient to hold the tool in place while one changes his hold on the handles; but it is readily released by a slight reverse pressure on the handle *B*. In turning the nut the pressure from it comes so directly on the band *D* that there is little or no tendency to separate the handles.

Florence, Mont. W. D. G.

## Taking the Wrinkles out of Blueprints

We all know how annoying it is to have blue or other prints roll or curl up when we are referring to them. They are particularly bothersome after being folded or rolled for mailing, especially if not entirely dry when done up.

To save patience, and bad language, soak the prints for a minute or two in a tank of clear, cool water and hang by one edge on a line or bar, out of the direct rays of the sun, to dry. If carefully handled they will not be injured a particle by this treatment and will be as flat and smooth when dry as when first made.

Detroit, Mich. J. C. AUSTIN.

## An Interesting Job on the "Manufacturing Automatic"

The sketches show some tools used on the Potter & Johnston "manufacturing automatic" for machining a door-check body, sectional views of which are given in Figs. 1 and 2.

In Fig. 1, which is the first operation, *A* is the roughing bar with tools for boring out the hole *a* in the work; *B* is a finishing tool. The door check is held in a fixture fastened in the chuck, while *C* is a plug fitted into the nose of the spindle. The boring bar *A* has two cutters, *D* and *E*, so arranged that the two straight portions of the hole *a* in the door check can be bored at the same time, thus saving the time of going over the recess *b*. The tool *D* is held in a plug *F* by means of a small set screw, and the plug is prevented from turning by a small pin fastened into the plug and fitting a slot in bar *A*. As the turret of the machine moves forward and the plunger *G* comes in contact with plug *C*, the plunger is pushed backward relative to bar *A*, and forces plug *F* with cutter *D* out of its groove, and when the highest point of the plunger is reached cutter *D* is out to its farthest point. The cutter is adjustable in its carrying plug *F*, so that the correct diam-

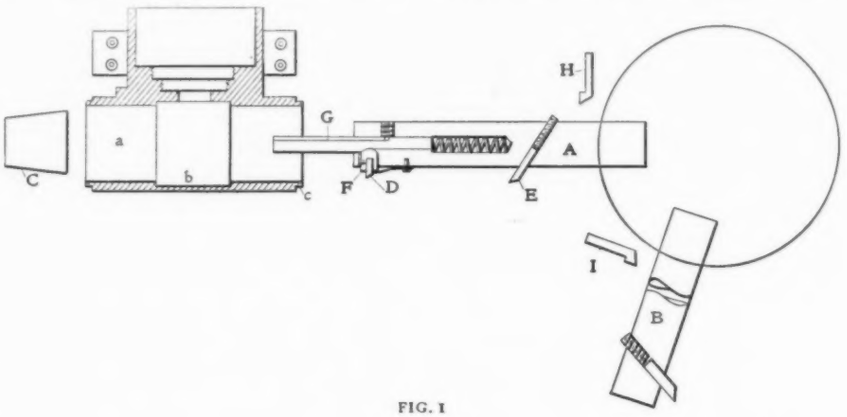


FIG. 1

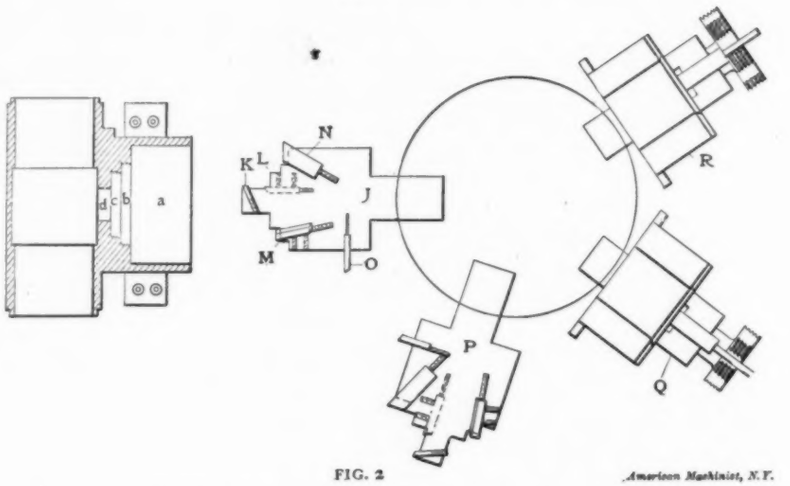


FIG. 2

American Machinist, N.Y.

TURRET TOOLS FOR MACHINING DOOR CHECKS

eter of the hole can be readily obtained. In this way the two cutters start operations at the same time. There is a groove in the upper side of plunger *G* and a set screw with a small tit on the end which fits into the groove, prevents the plunger from turning. The spring behind the plunger pushes it forward to the starting point when the work is finished. When the plunger is pushed forward by its spring, the plug *F* with the tool *D* is pushed back into its groove by means of a flat spring fastened to the boring bar with a screw. As will be noticed there is an adjusting screw behind tool *E*. The tool shown at *H* is for turning the small diameter *C* at the end of the work.

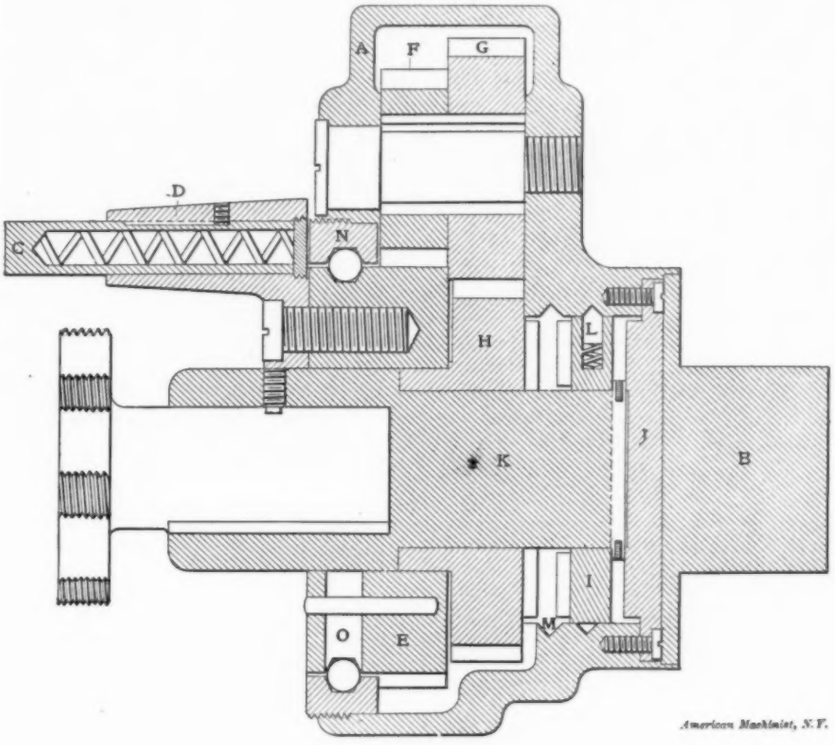



FIG. 3. TAPPING DEVICE

The finishing boring bar *B* carries an adjustable cutter at the end. The finishing turning tool is represented at *I*. Although there is only one cutter in the finishing boring bar there is not much time lost with this tool on account of the speed being increased. Where there are only two tools to be used, a rougher and finisher in the machining of a piece, the machine is tooled up double, thereby giving two finished pieces to one revolution of the turret.

The second operation on the door check is shown in Fig. 2. The nut is gripped by special jaws in the chuck and the roughing boring head *J* brought into operation. This head carries a cutter *K* for boring hole *d*; cutter *L* for boring *c*; *M* for boring *b*; *N* for boring *a*, and *O* for facing the end of the work. The arrangement of the adjusting and clamping screws for these boring tools will be understood from the sketch. The tools carried by holder *P* are the same as those described, except that they are for finishing the bores. The tapping device *Q* is for tapping bore *c*, and *R* is a similar mechanism with a larger tap for tapping *b*.

Fig. 3 is the sectional view of the tapping mechanism with *A* the body, *B* the hub, *C* the driver stud containing a spring as shown, and prevented from turning by a screw, which fits into a slot in the stud. *D* is the driver bracket which is attached by a screw to the driving gear *E*. *F* and *G* are intermediate pinion gears, *H* a clutch gear and *I* a clutch. The clutch yoke *J* is held in place by the screws shown.

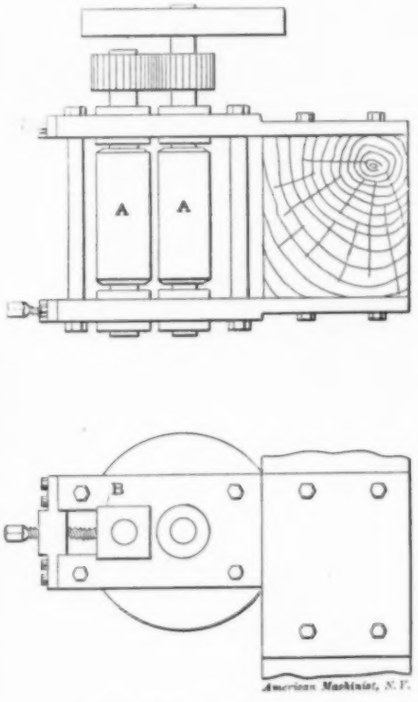
The operation of the tapping chuck is as follows: The driver stud *C* driver bracket *D* and driving gear *E* are driven by means of a bracket fastened onto the chuck, which revolves the driving gear by means of the stud. The gear in turn revolves intermediate pinion gears *F* and *G*, which also in turn revolve clutch gear *H*. This is for the extraction of the tap. To tap out the hole a special cam is put onto the drum of the machine with the exact angle, to correspond with the pitch of the thread. The tap is fed in until the end of the cam is reached, there being a small dwell on the end of the cam which allows the tap to pull the tap socket *K* with clutch *I* fastened to it, out of the clutch yoke *J*. As soon as the clutch is disengaged the spring plunger *L* forces itself into the groove *M*, thereby engaging the clutch with clutch gear *H*, which revolves the tap. While the tap is being withdrawn the slide of the turret is moving backward at the same speed. As soon as the tap is extracted the machine changes onto the fast speed, carrying the tap away from the work. The ring *N* with the ball bearings gives a free and easy running gear. The steel plug *O* fills the hole through which the balls are put in place, and prevents them from falling out. Any size tap can be used with this chuck, and the same results can be obtained every time.

Providence, R. I. A. B. MANN.

## A Red Lead Putty Grinder

As a usual thing we had two men pounding and beating putty and red lead to prepare it for making joints. Besides being slow and expensive the putty was not always well mixed. The accompanying cut shows how we saved time and money and also obtained a better mixture.

*A* are two 3½-inch rolls, in this case turned from a car-axle, set between the two cast-iron sides. The brass bearing *B* is made in one piece, and by means of the set screw the rolls are opened or closed as desired. The whole thing is mounted on an 8-inch wooden column by four ¾-inch bolts. Power is taken from any convenient shaft which in this case happened to be the forge-fan shaft. Some convenient vessel is placed under the rolls and one man can pass through in one day more than two men could pound into a mixture in three days.




A RED LEAD PUTTY GRINDER

Preston, Cuba. R. A. ANDERSON.

# Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

## WE PAY FOR THESE ALSO

### Dimensioning Detail Drawings

I was interested in the article by Mr. Henning, at page 166, on the above subject, and should like to offer a few remarks on the points raised. Before discussing various systems of dimensioning drawings, it may, perhaps, be well to go to the root of the trouble as evidenced by the examples shown in the article referred to, and ask the question, "Are draftsmen sufficiently acquainted with current machine-shop practice?" Upon looking at Fig. 1, the answer is obvious, and we know quite well that this is not an isolated example, yet is the draftsman wholly to blame?

His work, assuming he intends sticking to the profession, does not lie, for any considerable time at all events, in the machine shop, studying intricacies of machine tools, or their capabilities, but in developing various mechanical combinations for a particular purpose, which may, or may not, call into use his practical knowledge. He is not called upon to decide how the part is to be dealt with in the machine shop, so that this becomes a secondary consideration.

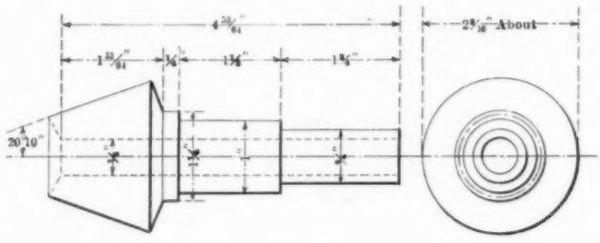
Strictly speaking, except in isolated cases, the draftsman must devote his whole time to theoretical development, in order to equip himself for his profession, so that his acquaintance with uptodate machine-shop practice is not such as to enable him to keep costs of production always at a minimum. This being so, it would appear to be necessary to have all drawings passed through the hands of a man whose practical knowledge, combined with a thorough acquaintance of the plant on which the parts are to be produced, where this is possible, enables him to detect any particular detail likely to cause unjustified expenditure, or where, by a slight addition or other alteration, facilities for machining would be greatly enhanced.

Summarizing Mr. Henning's complaints, these would all be provided against by the adoption of such a check, while economy and expedition are obtained, even neglecting the time at present lost in the shops due to a lack of sufficient information. As regards finish of the drawings, it is much more important, although the fact is not always appreciated, to have a plain, accurate drawing, than one embodying a variety of washes and artistic shading, but on which it is impossible to balance up the dimensions, or where the figures and lettering can only be deciphered with difficulty.

Turning to other points brought up, the method of indicating dimensions and limits is one of the most important. I do not agree that the system of indicating these "does not matter much," but that consideration should be given the men who must read them. Men are not wanting who take fright at a dimension containing four or five decimal places, and who are compelled to spend time finding out what is required in plain figures. While admitting that cases do occur where, to insure a certain result, it is necessary to give the dimension in decimals, these are isolated and do not call for the adoption of the system throughout. Experience proves conclusively—speaking in a broad sense—that advantage is gained over decimals by the use of fractions, the man in the shop feeling much more at home with 2 5/32 inch than with 2.15625 inch, besides which, in the latter case, he must reduce the decimal to a fraction before applying for any tools or gages he may require for the job, a procedure always open to error in itself, and occupying time. It may be argued that a man very quickly becomes accustomed to decimals and is soon able to read them as easily as fractions; this may be so or may not; all depends on the man and it must be borne in mind when adopting a system, that it is not the shop mathematician who alone has to be catered to, but those men whose aptitude for figures is not always in direct relation to the work they are capable of producing.

As to limits, I am in favor of showing these in the manner marked *A*, Fig. 2, because in the first place, one is able to see at a glance exactly what tolerance will be permitted and in which direction, while the correct dimension can also be at once read off. *B* is simply a longer way of conveying the same meaning, occupying more than three times as much time in writing, while no advantage is gained whatever. Limits should be shown or understood on *every* dimension for machined surfaces, so that the shop knows exactly what is required.

The fixing of allowances is a point, not by any means receiving the attention its importance merits, many firms at present simply having an arrangement of curves indicating the allowance for various fits, but making no distinction whatever between those required for different classes of work. For example, it is obvious that a 4-inch shaftto run at low speed, should not have the same allowance as a similar shaft required to run at high speed. To obtain best results each allowance should be considered on its own merits, having regard to the particular requirements of the part and not be obtained from fixed curves, ignoring classification. Allowances and limits should be fixed and placed on the drawing by the practical man advocated above, before issuing to the shop, thus obviating the necessity for the machinist to waste his time looking up charts or curves.




American Machinist, N.Y.

FIG. 1 FIG. 2

DIMENSIONING DETAIL DRAWINGS

In the case of limits, the greatest possible latitude should be allowed, having due regard to interchangeability restrictions, which item, however, does not by any means necessitate close limits in all instances. Opinions are at variance as to whether necessary allowances ought to be made in holes or on shafts, but there is little doubt as to which method is the more economical of the two. If further convincing is necessary, let it be seen how many holes may be reamed without alteration in size, or adjustment of reamer and that with the best reamer to be procured.

The points raised by Mr. Henning are of equal importance to the specialty shop and the general shop, and expression of views and experiences cannot but prove beneficial, whatever the class of work.

H. PEARMAN.

Basingstoke, England.

## Testing High Speed Steel

I have read with interest the articles by Mr. Osborne and "B. J." on "Sammy's Troubles with High Speed Steel," and while B. J.'s explanation is humorous, it does not enlighten us as to the way it should be done.

As in everything else, there is a theoretical way and a practical way of doing this, and, therefore, I beg to throw a little light on the subject by describing the way high-speed steels are tested by the Wagner Electric Manufacturing Company, St. Louis, Mo.

As regards drills, we buy all the different kinds of high-speed drills on the market. These are placed in a multiple-drill press with carbon or other high-speed drills and used for regular productive work. The man operator is instructed to notify the foreman when any of his drills require grinding. The condition is noted and if the high-speed ones are being tried in comparison with carbon drills, the carbons are ground, the number of holes they drilled are noted and the drills replaced, if the difference in length, due to grinding, is not sufficient to cause trouble. If two different kinds of high-speed drills are being tried out against each other, they are run until one or the other requires grinding. After the number of holes and inches of material have been noted, both are reground and tried again. In some cases they are tried three or four times.

In regard to lathe tools, the average salesman is informed that we have determined upon the brand of tool steel we wish to use, and that we do not care to make any change for a year, without regard to the fact whether we have the best tool steel or not. However, when an agent calls who represents a firm whose standing and reputation merits a hearing for their claims, we tell the agent to bring a piece of tool steel, of a certain size, with him, or have it shipped to us.

When we are ready, the agent and myself go to the shop and the blacksmith is instructed to make up a tool of the steel we are using and one from the sample presented by the salesman, following, of course, the salesman's instructions regarding treatment for his brand of steel—but his verbal instructions only. When the tools have been tempered they are sent to the grinding room and ground on a Gisholt grinder with the proper clearance angles. They are then put into the tool post of a lathe and tried out on regular production. The speeds run from 75 feet per minute with a 3/8x0.021-inch cut to 145 feet with 3/32x0.010-inch cut. The number of shafts the tool will turn, or the number of minutes it will last, determines its merit.

If the agent's sample fails, it is retempered if he so desires; if it again fails, it is rejected as far as we are concerned. For his own personal satisfaction there is no objection to his tempering the steel himself and our trying it again. But to get results, the blacksmith must determine the steel used—meaning by this, that although one steel may be intrinsically superior to another, the ability of our blacksmith to consistently temper it is the final test as far as the Wagner company is concerned.

Even should the agent's steel prove superior to that which we are using, none of it would be purchased should the treatment differ from that already in use, as, while the initial treatment might be successfully accomplished by the blacksmith, it is almost certain it would be lost sight of and the subsequent forgings and temperings would be similar to those given the steel already in use.

Finally, when we take into consideration the fact that very little high-speed steel is worked to anywhere near its maximum capacity, we are fairly safe in choosing one brand of steel and sticking to it. I believe that in some shops high-speed steel is being driven as low as 25 feet per minute on steel. For such work carbon steel would be as good as if not better than high-speed. We have allowed our enthusiasm for high-speed steel to carry us beyond reasonable limits in a great many cases.

As regards the new superior steel, we have found it necessary to use this on some of our machines, and happily the treatment of this is almost similar to the treatment given our ordinary high-speed steels of another brand and no trouble has resulted so far. The assigning of this steel to jobs, or machines, is, however, entirely in the hands of the superintendent.

Apropos of agents, I would like to give my experience with a French count(?) who called to sell us some high-speed steel. He paid his visit in Prince Albert and high hat, but had forgotten to clean his teeth and finger nails. He sent in his card to the general manager, who, happening to be busy, referred him to the assistant general manager. After talking with him for some time I was summoned, and told about the wonderful properties of the steel of which the count(?) had a small broken sample. Showing on the sample were several small specks that looked like silver, and from the leading questions asked and the number of times I was requested to examine the sample, I gathered that he wished me to inquire what the specks were, and he would then probably inform me that they used silver in the manufacture of the steel, as he had already informed me that it was a secret costly formula that was used. I informed him that we had already picked out our steel and did not care to make a change for a year. He was very insistent about sending samples, and wished me to make him a memorandum of the size we used and he would have samples shipped to us, but I refused to do this.

During the course of our conversation he invited me to his chateau in Paris and assured me of a good time, etc. The assistant general manager was called from the office about this time, and the count(?) informed me that any orders that were placed by the company would mean a substantial benefit to myself. I informed him that we did not do business in that way, and that I did not care to use his steel under any consideration.

When the assistant general manager returned to the room the count (?) informed him that I was very much behind the times and very ignorant concerning high-speed steels, and that I did not have the best interests of the company at heart, and he would suggest that the assistant general manager order some of the steel on his own initiative, forcing me to use it, assuring him of the great saving to be made. He was informed, however, that it was entirely in my hands, and as far as we were concerned the matter was at an end.

The count(?) then left the office, after borrowing a package of cigarettes and attempting to make an engagement with the telephone girl, and the next we heard of him was through some of the people to whom he had made sales, and who had evidently bought 69 cent and received 17 cent steel. Some of the large railroad corporations were stuck to the tune of several thousand dollars, and finally used the "high-class tool steel"(?) for any purpose they possibly could.

An English nobleman(?) has called since, but each and every one is informed that we have chosen our steel for one year and do not care to change it, even though a better steel were offered us.

This may not be considered progress by some, but it is certainly economy, and while I may not be able to tell which steel contains the highest percentage of tungsten, etc., I can tell which works out best for our purpose, simply because our blacksmith gets uniform results from it.

St. Louis, Mo. CHESTER B. LORD.

## A Problem in Stresses

Sickness has prevented me from again taking up the matter of the stresses in a casing, which I brought up at page 662, Vol. 32, Part 1. I have been in hopes that it would result in a discussion which would be of benefit, as the difficulty is a real one with me, but so far have been much disappointed.

The article by J. S. Myers, at page 1075, of the same volume, while profuse, does not shed any particular light on the subject, as he has only amplified the method outlined by me, and introduced stresses which I had ignored. If I should calculate the section of a casing by his method of summation I would have to increase a section, which, in all that I

have designed so far, has proved to be abundantly safe.

The effect of the curvature of the cantilever due to the circular form, as shown in Fig. 2, page 662, he does not touch upon at all, although its effect must be very pronounced.

One feature of Mr. Myers' article I, however, fail to understand. His formulas are the familiar ones for ordinary straight-line cantilevers and are not modified in any way, but he follows them by saying, "Since the cantilever is free, but guided on the inner end."

Can I get any more light?

Philadelphia, Penn. I. G. NORMAN.

## Testing the Pyrometer

On page 588 of the AMERICAN MACHINIST, under the title of "Why Are Pyrometers Discarded?" I find mentioned a good method of checking up the reading at high temperature.

There seems to be no doubt about the trouble of securing correct readings at times. This makes it imperative that the pyrometer be checked up occasionally, in comparison with some standard of known temperature.

For high temperatures the method set forth in the above mentioned article seems to be a cheap and inexpensive way; but for lower temperatures, say, from 300 to 1000 degrees Fahrenheit, a more simple method has been employed by me with good results. The standard of comparison was a high-temperature thermometer reading up to 900 degrees Fahrenheit.

A quart of heavy oil having a high boiling point was heated in an ordinary plumber's iron pot over a fire to the boiling or flash point. The thermometer was immersed in this together with the fire ends and the readings taken very readily. Corrections for different temperatures may be made as the oil cools off.

It might be well to call attention to the necessity of having good contacts in the wiring and instrument.

The cause of much trouble, delay and incorrect readings was found to be in the switch of the electric recording instrument which was remedied with a piece of fine emery cloth.

The use and abuse to which instruments are subjected at times causes more trouble than poor design or improper construction.

New London, R. I. G. S. STRING.

## An Experience with a Cutting Compound

Noting the article at page 335, "What is the Action of a Lubricant or Coolant on a Turning Tool?" I would like to state my experience with a bolt cutter, when in charge of a shop about two years ago where they got a rush order for a large number of 1¼-in. round iron bars threaded one end right-hand and the other one left-hand for about 2 inches. The specification read that these threaded ends must be free from grease as these bars were to be used in concrete.

I tried soda and water with indifferent result. The dies had to be ground too often. As the machine ran 22 hours out of the 24, this grinding caused too much delay. We sent for an expert from the company who manufactured the machine and he said "lard oil." We tried lard oil with better results, but had to remove the oil from the threads. It cost as much to remove this as to cut the threads.

In a day or two a man came in with a "patent medicine," a cure for all turning tools and just the thing to be used on a bolt cutter. As I was up against it I agreed to try a sample of "Save Oil." He gave me about ½ pint and told me to have it mixed with 20 parts of water. What the stuff is or what it is made of I don't know, but it certainly was a cure-all in this case. The threaded parts rusted in about one hour after leaving the dies. We got the sample in the morning, and in about four hours it became quite warm, so we added a little water and a good-sized piece of ice and telephoned for some more.

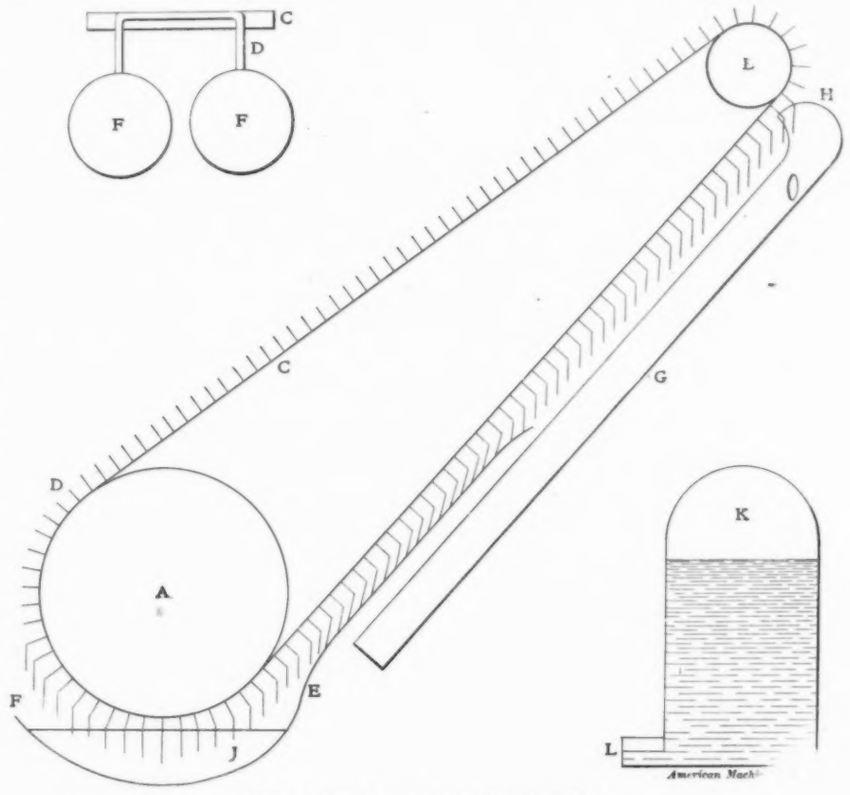
We had four right-hand and four left-hand dies. Our method was to cut one hand until the dies needed grinding and then cut the other hand. We found we had to change dies every five hours. Some bars were iron and some steel.

As to whether the lubricant gets between the tool and the work I will say, lard oil will manage to get all over, even soak into the material. With the compound mentioned I can't say where it gets, but the cooler the better both for threading and drilling. I found that diluting it did not impair its good qualities, as long as it retained its white color and was cold.

New York City. HERMAN JONSON.

## Lacquering Steel Disks

I noticed your correspondent's query on page 404, Vol. 32, Part 1, asking for a method of lacquering steel disks 1 inch to 1¼ inches diameter and also the method given by Mr. Petitjean on page 32, Vol. 32, Part 2. An idea occurred to me when I first read the query but as I am not in this line I refrained from writing. However, after reading Mr. P's method I am encouraged to send mine which I think would be better than his as in his method I cannot see how the disks would have a nice clean finish on the side which comes in contact with the canvas belt and also how they get on to the belt from between the rubber-covered rollers unless it licks them up off the bottom roller. In my method I should make use of magnets to hang the disks on while they are dipping and drying. The cut makes the idea clear. *A* and *B* are pulleys, *C* a leather belt having a number of magnets *D* forced through it and which is driven at a slow speed by the pulley *B*. *E* is a trough for lacquer, having an apron under the belt as shown. *G* is a chute (shown with the side removed) to conduct the dried disks into a suitable receptacle. The curved part *H* has slots in it to allow the magnets to




DEVICE FOR LACQUERING STEEL DISKS

pass it. In operation the disks are put on as shown, then they go through the lacquer *J* and travel up the apron of *E* so as to wipe off the surplus and finally they catch in the curve *H*, are pulled off the magnets and tumble down the chute *G*. It will be understood that the length and speed of the belt can be regulated to suit the rate of drying of the lacquer. The disks would hang as shown in the detail view. The level of the lacquer could be kept constant by means of an arrangement similar to the water bottles used for poultry. This is shown in the detail view. When the level of the water in *L* falls below the small opening into *K* a bubble of air slips in and displaces sufficient water from *K* to restore the level in *L*. The belt could be a broad canvas one having a number of rows of magnets so it would keep a boy fully occupied to supply it with disks. If it was worth while it would be an easy matter to make an automatic arrangement to feed the disks to the magnets. Other small articles could be lacquered by this method and no doubt it could be adapted to lacquering larger articles.

Bradford, England. HAROLD SMITH.

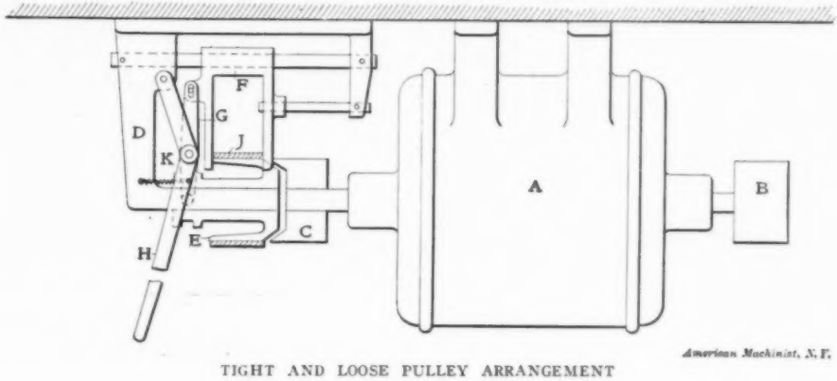
## Tight and Loose Pulleys

I read with interest the article on "Tight and Loose Pulleys," on page 983, Part 1. I came across an arrangement some time ago which had been made to serve the same purpose, but which I think is a better method inasmuch as there is only one belt shipper to move in order to put the belt onto either the tight or loose pulley.

The arrangement was put up in a workshop which was to be driven by an electric motor hung from the roof and driving a line shaft at each side of the shop.

One side of the shop would be running the greater part of the day and the other side would only be working at odd times. It was thought that it would be better if that side of the shop could be stopped completely, including the main driving belt, and so the arrangement shown by the accompanying cut was made.

Referring to the cut, *A* is the electric motor hung from the roof. At one end of the armature shaft a pulley *B* is fixed which drives the line shaft at that side of the shop which runs continuously. On the other end is mounted the pulley *C*. The face of this pulley is recessed like a cone clutch at an angle of about 45 degrees.




TIGHT AND LOOSE PULLEY ARRANGEMENT

Mounted upon the hanger *D* is a pulley *E*, the front end of which is coned to meet the recess in *C*. The boss at back end is grooved so that it can be moved longitudinally by means of a shipper lever.

The pulley *E* and belt fork *F* are connected together by the lever *G*, as shown. The belt-shipper lever proper *H* is slung from above and is connected to the lever *G* near its bottom end so that when moved in either direction a lot of pressure is brought to bear upon the pulley *E*, and very little upon the belt fork *F*.

By this arrangement, when the shipper lever *H* is moved over to the right toward the motor *A* the lever *G* takes a heel off the belt *J* through the fork *F* and moves the pulley *E* into contact with the moving pulley *C*.

The pulley *E* now begins to revolve with *C* and so also does the belt *J*. As soon as the belt is moving at a suitable speed the pressure which is being exerted on the fork *F* swings it over onto the pulley *C*. The lever *H* is now let go and the pulley *E* is brought out of contact with *C* by means of the spring *K* and therefore comes to rest.

It will be noticed that there are no moving parts whatever at any time except when the belt is being moved from the loose to the tight pulley and *vice versa;* and also that the driving belt *J* is at rest when not being used for driving its line shaft. Finally I might state that the above arrangement has worked with every satisfaction since it was put up.

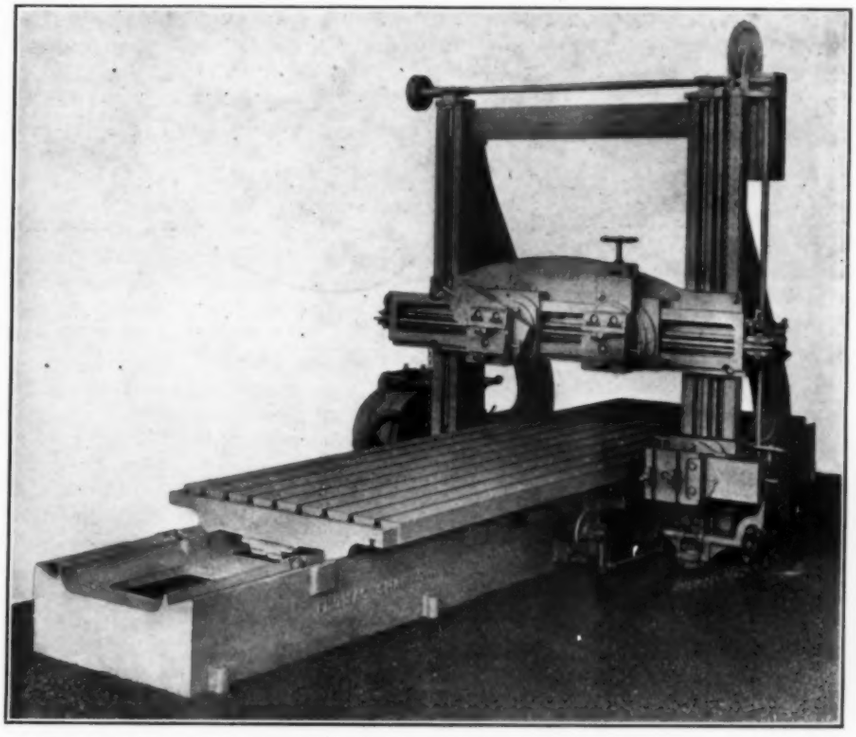
R. H. DICKINSON.

Accrington, England.

## Planer Ways

We are rather interested to see the illustration on page 298 of the new(?) planer way.

We originated this plan, and have adopted it on all our planers for over a dozen years, and have found its theoretical advantages borne out in actual practice.



PLANER WAYS USED BY THOMAS SHANKS & CO.

The photograph shows our arrangement, and you will observe that the French builders reversed our plan, they making the flatter angle on the inside, whereas ours is on the outside.

THOMAS SHANKS & CO.

Johnstone, Eng.

# AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During* 1908 *we printed and circulated* 1,205,750 *copies of the* AMERICAN MACHINIST. *Our circulation for September*, 1909, *was (weekly, monthly and European)* 111,750.

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|---|---|
| *October* 7 | 36,250 |
| *October* 14 | 19,000 |
| *October* 21 | 19,000 |
| *October* 28 | 19,000 |

*This paper reaches* 36,250 *separate readers each month and* 19,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*


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## Harder Wearing Surfaces for American Machine Tools

Our readers are well aware that one of the points, and perhaps the leading point, on which American machine tools have been criticized in Europe, lies in the fact that they are made of softer iron than is the practice across the water, this being a criticism which comes to us so frequently that its truth can scarcely be doubted. Its reason, of course, lies in the comparative nature of American and European irons, out of which different standards of hardness for wearing surfaces have developed.

The criticism relates chiefly to the guiding surfaces of lathe beds and other members working under similar conditions, because the indifferent lubrication of those surfaces is particularly unfavorable to endurance under use. When properly lubricated, cast iron is, without doubt, the best wearing material in existence, even though it be comparatively soft. The well-known glaze which soon characterizes cast-iron wearing surfaces which are well lubricated is formed on soft as well as hard castings, and under conditions of adequate lubrication it is doubtful if harder iron than that used here has any particular advantage.

In the case of lathe shears and similar members, the conditions of lubrication are, however, different and there can be no question that our machine-tool builders would further their interests by a change in practice.

It so happens that this is an easy matter which does not involve a radical recasting of foundry practice as regards mixtures. On page 1417 of our volume for 1903 we published from the pen of Henry Hess an article entitled, "Chilled Machine Tool Ways," giving particulars and results of his own use of this process, and again on page 271 of our volume for 1905, Part 1, we published an unusually complete article on the foundry methods of the Landis Tool Company, wherein was included their practice in chilling the guiding surfaces of their grinder beds. The first article was, we believe, the first published account of this process, while the second went so far as to give the thickness of the chills used under various conditions, together with other features of the practice, and the fact was made plain that the increased cost was too small to be worth considering. The plan now has the indorsement of continued use of the Landis works where it long ago ceased to be looked upon as a novelty.

At the time of their publication we regarded these articles as of fundamental importance in that they pointed out a perfectly feasible improvement of the most obvious advantage. The process offers to machine-tool builders a ready means of, not only improving their products, but of improving them at a point where they have been widely criticized by customers whose criticisms are worthy of attention. We are at a loss to understand why the practice has not become more common, and indeed universal, which it certainly deserves. We are prone to believe, and to boast of ourselves as the most progressive people on earth, but here is information of the most valuable character, given away without money and without price, through the use of which a universal criticism might be completely nullified, but to the best of our knowledge it has passed almost unnoticed.

Professor Sweet long ago remarked that it is impossible to give a good thing away, and this case appears to be a very apt illustration of the truth of his statement.

## Savings Bank Insurance

Savings bank insurance for wage earners is having a satisfactory growth in Massachusetts. The firm of B. F. Sturtevant & Co., of Hyde Park, has recently taken out an agency, and has an instructor from the Boston Chamber of Commerce.

After the advantages of the system are really understood its growth should be even more rapid. Industrial insurance as handled by some of the leading companies was shown to cost from two to eight times as much as ordinary life insurance with annual, semi-annual, or quarterly payments of premiums.

The Massachusetts scheme aims to give industrial insurance for the lowest possible cost consistent with sound business methods. Its success is such that already manufacturers in other States are becoming interested in its development and results.

## New Publications

METAL SPINNING. By Fred D. Crawshaw. 72 5x7-in. pages, with numerous illustrations and full page plates. The Popular Mechanics Company, Chicago. Price 25 cents.

The art of metal spinning has been largely superseded by the more economical methods of press work but there are many forms which are not readily made in presses, while to the amateur the spinning process possesses a peculiar fascination. The little book under notice is a praiseworthy attempt to put the essentials of the art before amateurs and others. The descriptions of tools and methods are extremely practical and ought to give anyone with a natural aptitude for the work a good start in it. Several of the halftone illustrations show work of genuine artistic value which any mechanic would be proud to acknowledge as specimens of his handiwork.

# New Tools and Machine Shop Appliances

## Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

## THE LATEST INFORMATION

### Four Spindle Gang Drill with Sliding Head

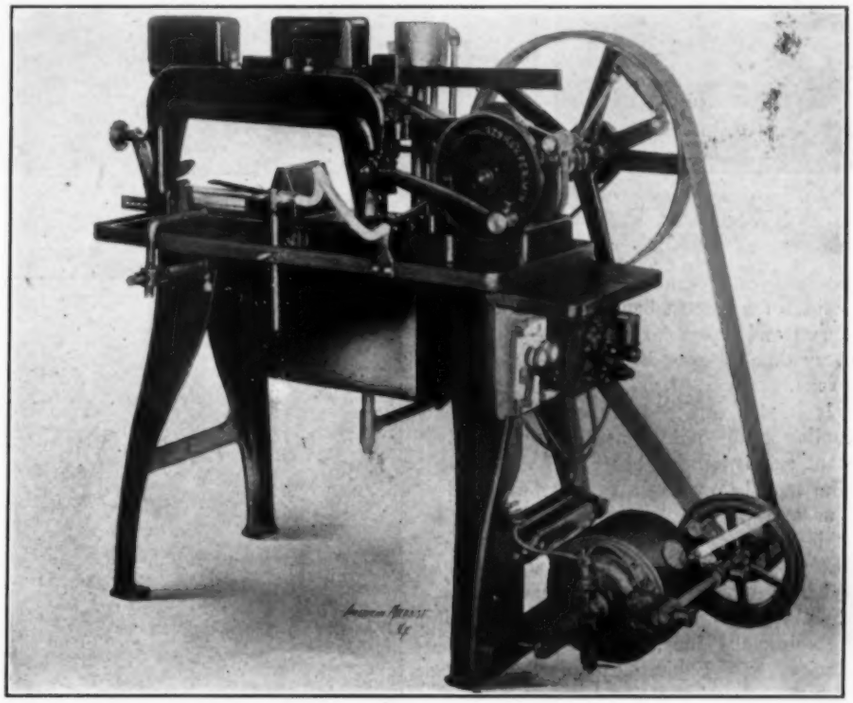
We illustrate herewith a new four-spindle gang drill built by the Cincinnati-Bickford Machine Tool Company, Cincinnati, O., each drill head being independent and having a sliding head. These are mounted on one base and have a continuous table provided with ample T-slots for holding work. Both the sliding heads and the spindles are perfectly balanced and can be quickly adjusted.

Ball thrust bearings are provided for all spindles, and each has three feeds operated by the mechanism shown. The spindle sleeve is graduated and provided with an automatic trip whenever power need be used. All gears are guarded, bevel gears are planed to insure quiet running and long life, all the spindles are driven by a continuous shaft at the back; each cone has its independent pair of bevel gears and a clutch is provided so that each spindle is independent.

There is also an oil pump for providing an ample supply of cutting compounds directly to the point of the drill. These machines can also be furnished without power feed, and in any number of spindles desired, either on a unit base as shown, or on individual basis if preferred, and with any form of table to suit the work in hand.

### Racine Motor Driven Hack Saw

This machine is self-contained in every way, having a motor mounted on the leg and driving the saw by gears and belt for speed reduction. The whole construction seems to be very rigid and it is designed to cut on the draw stroke as well as to positively lift the blade out of the cut on the return stroke. This is accom-



POWER HACK SAW WITH MOTOR DRIVE

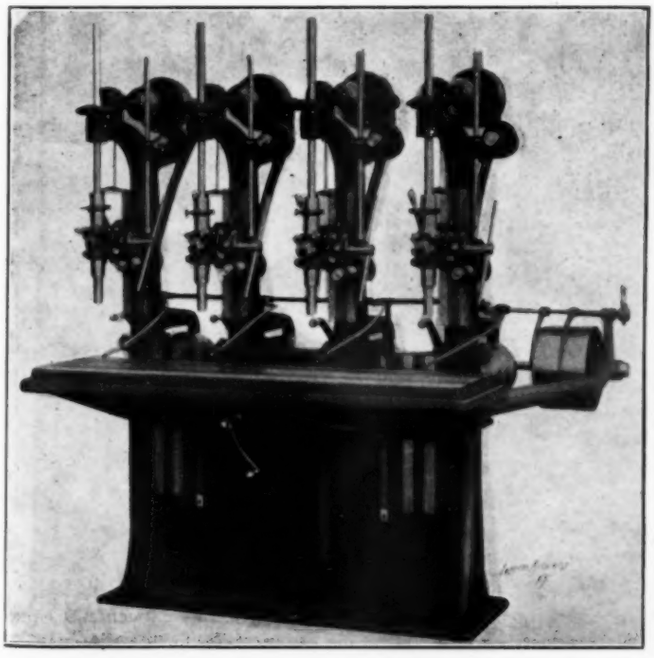


FIG. 1. FRONT VIEW OF 4-SPINDLE DRILL

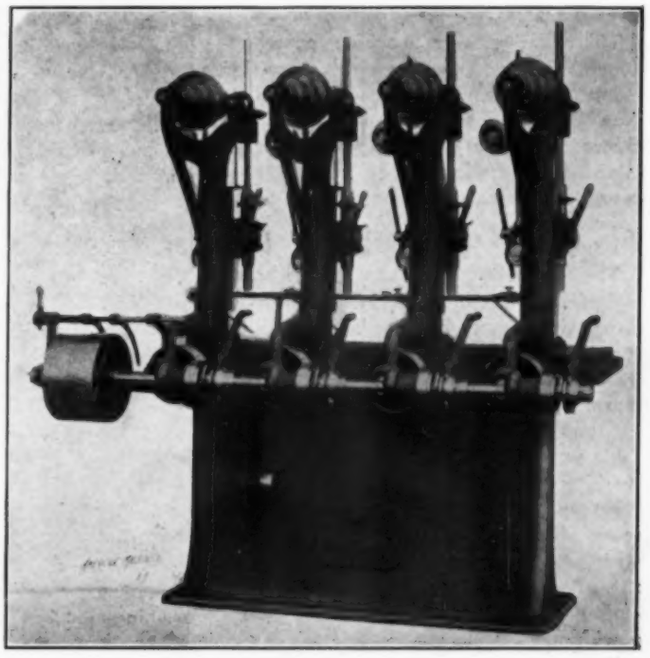


FIG. 2. REAR VIEW SHOWING THE DRIVE

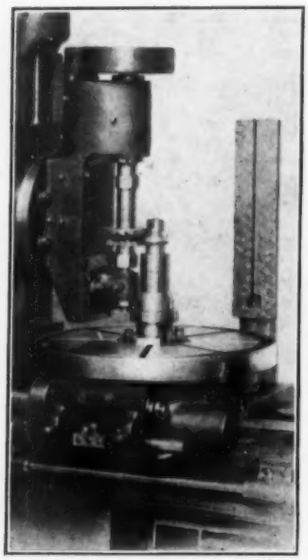


FIG. 1. MILLING BEVEL GEAR BLANKS

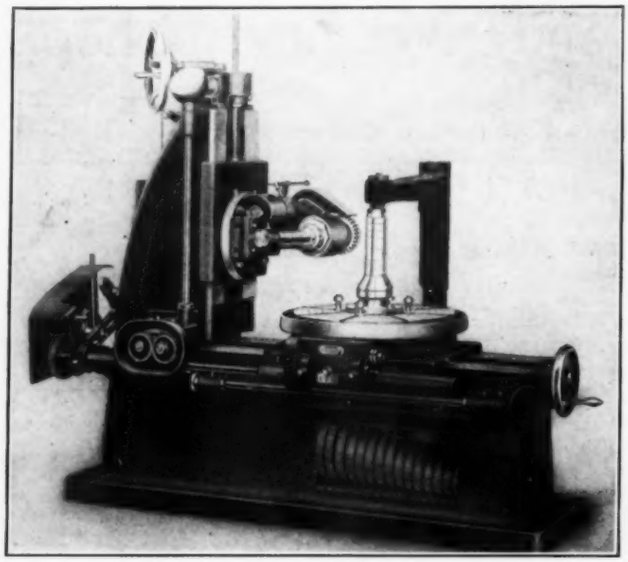


FIG. 2. GENERAL VIEW OF GEAR HOBBER

FIG. 3. CUTTING METAL SAWS

plished by an automatic lifting device consisting of a ratchet bar with its dog, and a cam and roller insuring a positive lift every time the saw frame makes a return stroke.

It is also equipped for circulating any cooling compound so as to keep a constant supply on the blade and the work. The tank below has a capacity of 4 gallons and the small reservoir into which it is pumped, holds one pint, which is always ready to flow to the saw blade. When desired this can be supplied on short legs so that the tank below will just clear the floor. This is built by the Racine Gas Engine Company, Racine, Wis.

## The Rhenania Gear Hobber

This gear-hobbing machine possesses a number of new features which are the result of experience with machines of this type. The upper portion of the bed, as shown in Fig. 2, serves as an oil tray, allowing the cuttings to go into the box beneath and the oil to be drained from these into the oil tank below, from which the lubricating pump takes its supply.

The swivel base and main spindle bearing of the head are cast in one piece, a large bronze taper bushing being supplied for the main bearing. The table is driven by a worm gear in the usual way, this worm being ground all over after hardening and having adjustable bearings for taking up the wear so as to insure proper meshing at all times. The end thrust wear on the face of the worm can also be taken up whenever necessary. A scale with a vernier is provided for adjusting the cutting depth and can be seen at the end of the flat way at the right of the machine.

The machine shown is the No. 3, having a normal capacity of cutting 40-inch gears,

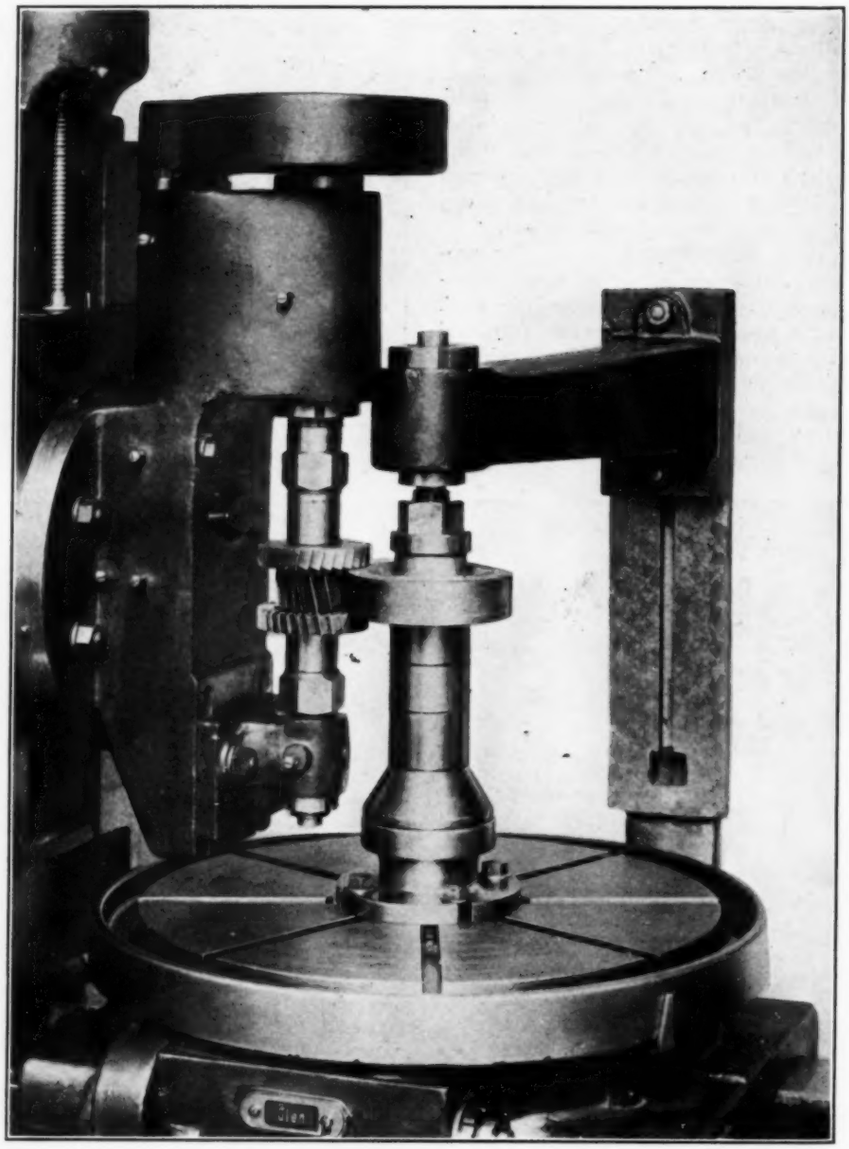


FIG. 4. MILLING GEAR BLANK

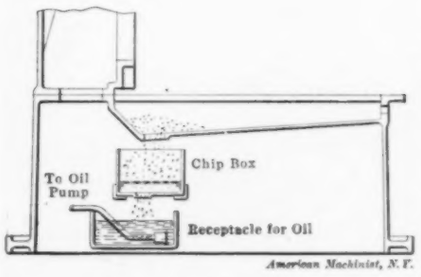



FIG. 5. SECTION OF BED

although it will handle light gears up to 50 inches in diameter. The width of face which can be cut varies from 13 to 18½ inches, the latter being possible where the gears are of greater diameter than the table of the machine. The maximum diameter of the cutter which can be used is 6¼ inches, while diametral pitches up to 2½ can be cut. The cutter arbor is 1¼ inches and the work mandrel 1⅝ inches. The machine is designed to cut plain spur gears but spiral gears can readily be cut by the use of the proper gearing attachment.

Figs. 3, 4 and 5 show interesting operations on this machine, giving an idea of the way in which it can be used in case there is not gear cutting enough to keep it busy at all times.

Fig. 3 shows it finishing spur-gear blanks by the use of a gang of milling cutters; Fig. 4 is a similar operation on bevel-gear blanks and Fig. 5 shows the hobbing of the teeth of metal-cutting saws by using a hob having the proper shaped

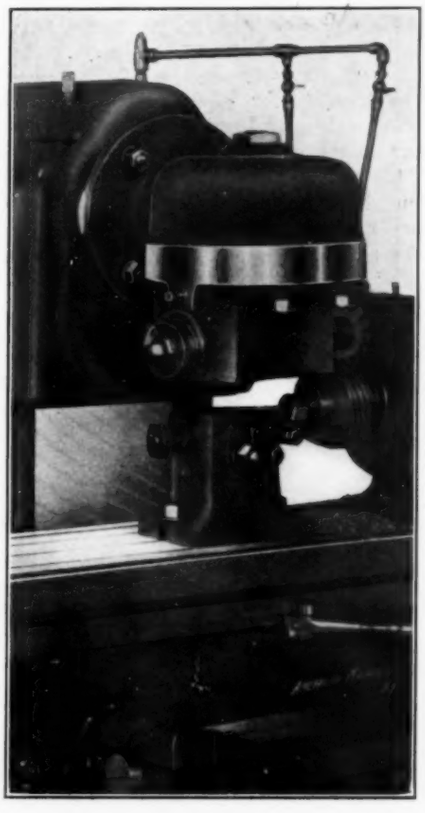


FIG. 1. CUTTING SPIRAL GEAR

teeth to produce the desired cutting tooth on the saw. A number of saw blanks are clamped in the fixture shown and cut at one operation the same as in hobbing a large gear. This machine is one of the late products of Alfred H. Schütte, 90 West street, New York.

## Substantial Universal Milling Attachment

Those who are familiar with milling-machine work do not need to be told of the advantages of a universal milling at-

FIG. 2. FOR VERTICAL MILLING

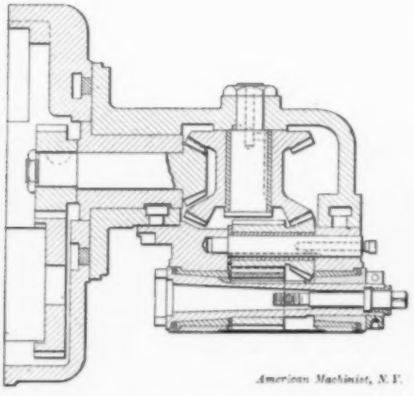



FIG. 5. DETAILS OF UNIVERSAL AND SPIRAL MILLING ATTACHMENT

tachment for many classes of work. The illustrations show the substantial attachment recently designed by the Kearney & Trecker Company, Milwaukee, Wis., to be used in connection with their milling machines. It can be set for any angle and is constructed for severe usage.

FIG. 3. SET AT AN ANGLE

As will be seen, this has a very substantial base which is clamped to the face of the milling-machine column, and the details illustrated in Fig. 5, show how the universal spindle is driven by the gear *A*, which is carried by the flanged end of the main spindle *S*. The upper driving spindle carries a bevel pinion on the end which drives the rather unusual combination of bevel gears and transmits power to the universal spindle through the wide-faced spur gears as shown in the illustration. The gears are made of hardened steel. Spirals of any angle can be cut on both universal and plain machines if the latter are fitted with universal spiral dividing centers.

Adjustment can be made in both directions, and the cutter set at any angle with either the horizontal or vertical that may be desired. It is provided with a No. 10 B. & S. taper, and will handle milling cutters up to a size 6 inches in diameter.

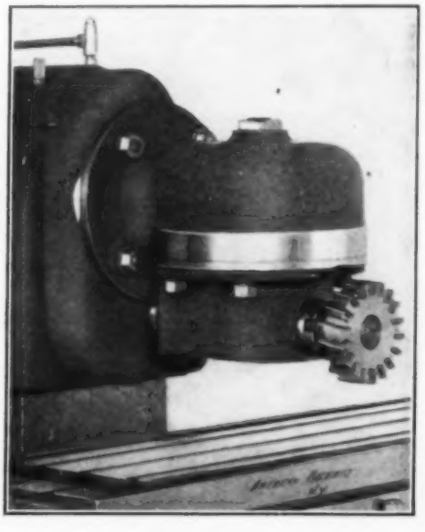


FIG. 4. HORIZONTAL MILLING

## An Automatic Gear Cutter and an Automatic Staff Turning Machine

Fig. 1 shows a gear cutter which will cut steel gears and pinions of fine pitch, and is especially adapted for cutting brass gears on account of the protection from chips afforded to the index, cams, slides, etc., by means of a plate attached to the cutter slide, and a removable cover which completely incloses the work and cutter, except for an opening below the work which allows the chips to fall through.

The index plate is large to insure accuracy of divisions, and by means of a single screw adjustment any even division of the index, ⅛ or finer can be obtained. As the cutter is lifted during the return of the work slide, indexing is done without loss of time. The work slide can be adjusted laterally in relation to the cutter, and for controlling the depth of the cut a graduated handwheel is provided at the top of the cutter slide. The cutter spindle is driven by a horizontal belt from an intermediate shaft attached to the machine, the countershaft being placed directly over the machine.

With a one-cut machine the feeding and indexing operations are automatically continued until all the teeth have been cut, when the machine stops. With a two-cut machine, after the work has been indexed around once, the cutter feeds a little deeper and the operation is continued until the second round is completed, when the machine automatically stops. The machine is made in two sizes. The smaller will cut gears up to 1¼ inches in diameter, 32 pitch in brass and 48 pitch in steel, the longest stroke of the work slide being 1⅜ inches. The larger machine cuts up to 3 inches in diameter, 24 pitch in brass, 32 pitch in steel, and the maximum stroke is 3 inches. For steel work a pan base and pump are provided.

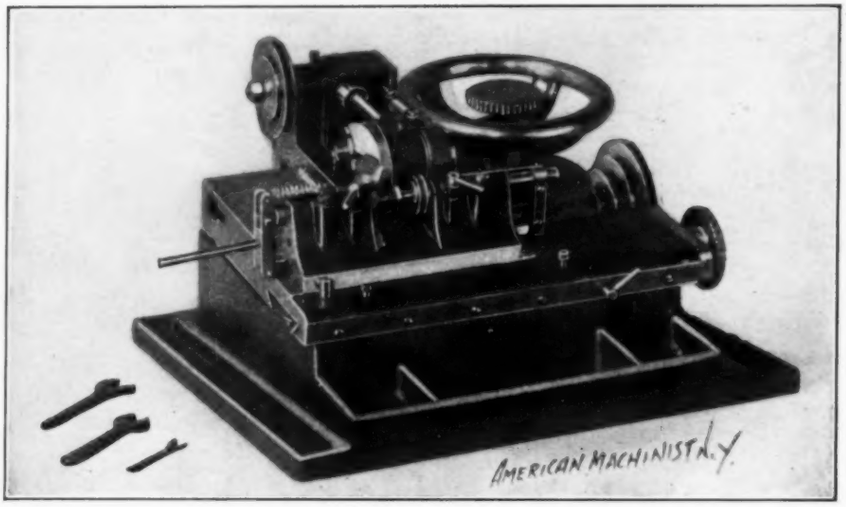



FIG. 2. AUTOMATIC STAFF-TURNING MACHINE

The automatic staff-cutting machine is shown in Fig. 2, and is built for turning several shoulders on small work, such as staffs of watches, clocks, etc., with one holding. The machine has two slides, one carrying the work between dead centers, and the other at right angles to the first for carrying the tools. Two cams are mounted on a vertical shaft at the rear of the machine, these cams being connected by a sliding wedge in contact with hardened rolls on the slides. Longitudinal movement of the wedges transmits a reduced movement to the slides, and any slight inaccuracies in the cams are, therefore, greatly reduced in the slide movement, and are not noticeable in the work. The cam shaft is driven by a worm and worm gear and a friction clutch connects the gear to the shaft. When this clutch is released, the shaft is turned by the handwheel, thus expediting the setting of the tools, etc. The cams can be cut so that the tool will turn either straight or tapered work, or a part of the staff may be straight and a part tapered, or different parts may be tapered at different angles. The cutting tool follows the course determined by the cams, turning, squaring off, etc., until all the shoulders on one end of the staff have been made. In the case of the single-tool machine, the tool then returns to its original position, and the machine stops for the insertion of a fresh blank. In the two-cut machine the tools are carried in a turret, which is indexed on the return after the roughing cut, bringing the finishing tool in position and the movements are repeated.

Both of the machines shown are built by the Waltham Machine Works, Waltham, Mass.

## An Adjustable Drill Jig

There are many places where a tool of this kind will be found a great saver of time and special equipment where it is not advisable to make permanent jigs. The cast parts are of malleable iron to guard against breakage, the steel adjusting screws having graduated micrometer dials for reading thousandths of an inch.

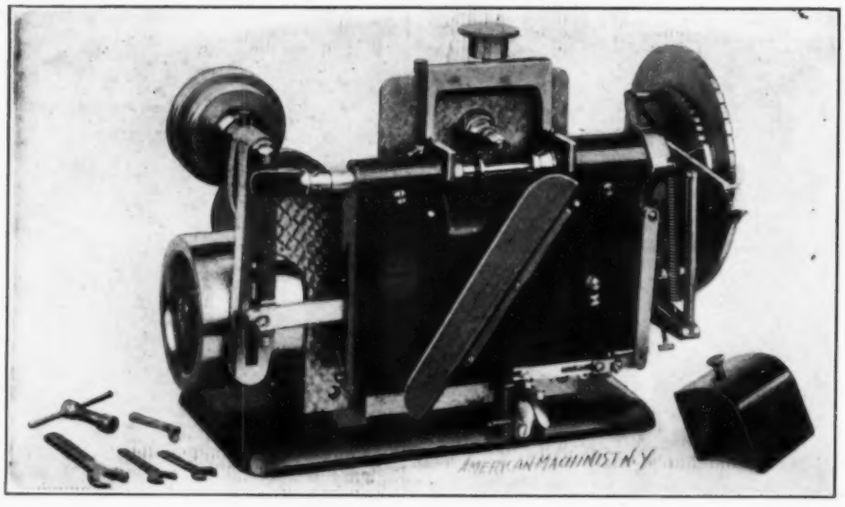
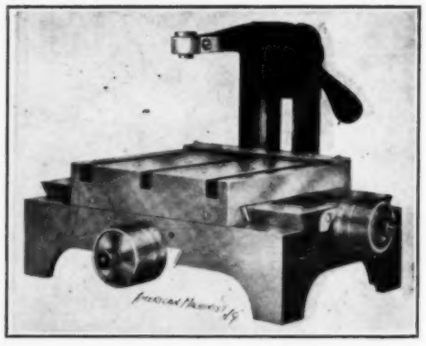



FIG. 1. AUTOMATIC GEAR-CUTTING MACHINE



ADJUSTABLE DRILL JIGS

The base is 5 inches wide, 8 inches long and 3½ inches high, the table being 5 inches square and having three slots, 5/16x7/16 for parallels or stops, while a gage is fastened across the top of the table at the back as shown.

The arm extends over the table 3½ inches, is supplied with a ⅜-inch bushing which can be replaced by other sizes as required. The bushing arm is adjustable vertically 2⅝ inches by the threaded handle at the back, and across the work by the front screw with graduated dial.

These adjustments make it easy to drill at any desired point within its capacity and enable light milling to be done in the drill press when advisable. It is easily handled, weighing but 15 pounds, and is made by G. R. Carlson, 367 Ellicott street, Buffalo, N. Y.

## Releasing Die Holder

The engraving shows the latest form of releasing die holder made by Wells Brothers' Company, Greenfield, Mass. This embodies the main features of the holder illustrated some months ago, such

RELEASING DIE HOLDER

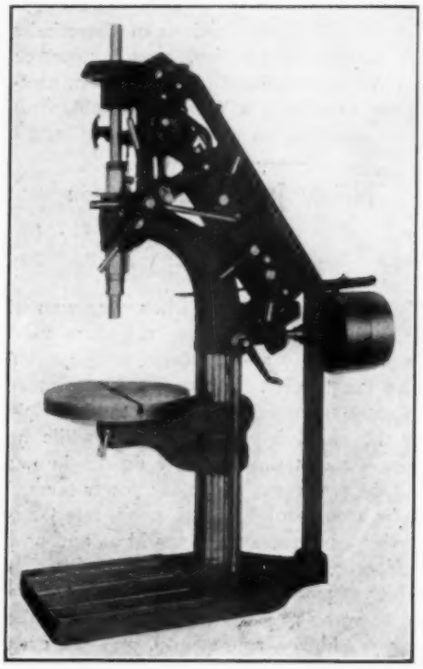
as the clutch teeth in the center of the holder which release when they are drawn out of engagement by the action of the tap or die, and the roller ratchet behind it allowing it to turn freely in one direction, making the backing off easy and safe. It works more quietly than the usual design.

In the holder shown the die can be located flush with the face and without any covering plate as formerly, which allows it to be used on all threading work, including running up to a shoulder.

The shank is hollow and will take any length of threaded piece.

## 24-inch All Geared Drill

This is a continuation of the line of all geared drills manufactured by the Barnes Drill Company, Rockford, Ill., be-



24-INCH ALL GEARED DRILL

ing the 24-inch machine. It has eight feed changes and twenty changes of positive speeds ranging from 0.0015 to 0.031 inch per revolution. All changes of feeds and speeds can be made without changing the position of the operator, avoiding loss of time in making such changes.

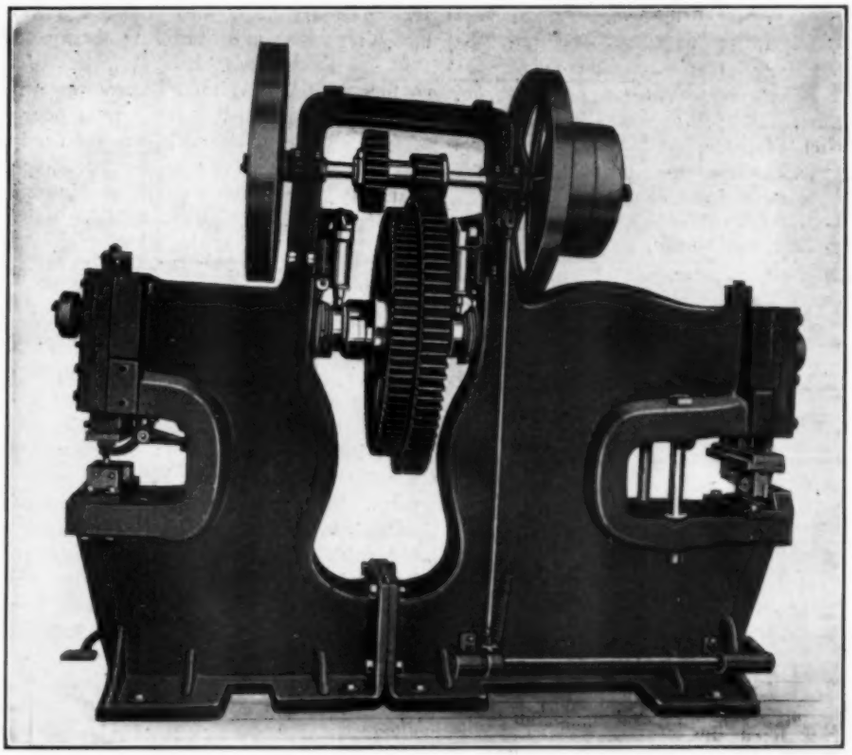
Tests have been made in which 29/32-inch carbon-steel drills have been driven through 2 inches of cast iron with the maximum feed and a speed of 64 revolutions per minute. High-speed steel drills 1 inch in diameter have been driven 258 revolutions per minute, through 1½-inch steel in 23 seconds.

## Combined Punch and Shear

The illustration shows one of the latest designs of the Covington Machine Company, Covington, Va., being a combined punch and shear with a sliding change gear for giving different speeds. This gear arrangement is applied to machines having a capacity for ⅞x⅞-inch punches or ¾x6-inch shearing material, and larger. These machines are made with either single or double throats and may be used both for punching or for shearing, or in combination as shown. Each end of the machine is independent of the other in every way, being equipped with the Wais automatic clutch and positive stop, which allows the punch to be brought close to the work and facilitates the location for new holes.

## Adjustable Bolt

The bolts shown are made in various sizes and lengths and are adapted for use on the planer, drill press, boring mill, or in fact in any place where a temporary bolt can be used. The type of bolt



COMBINED PUNCH AND SHEAR

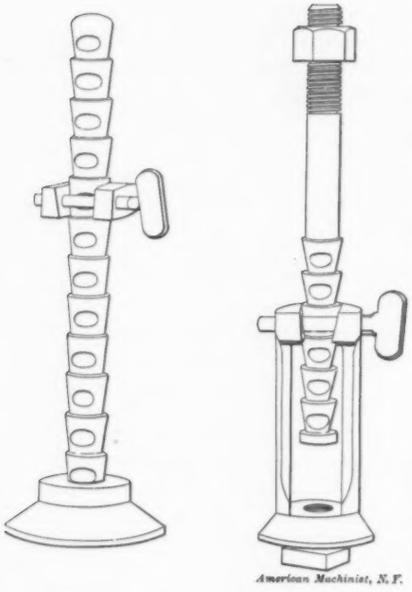



FIG. 1. FIG. 2
"RED WING" ADJUSTABLE BOLTS

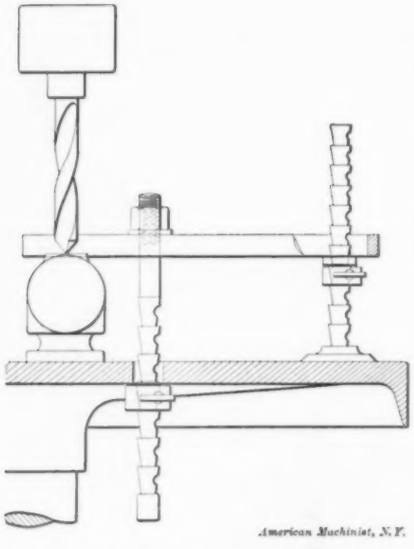



FIG. 3. BOLT AND REST AS APPLIED TO DRILL PRESS TABLE

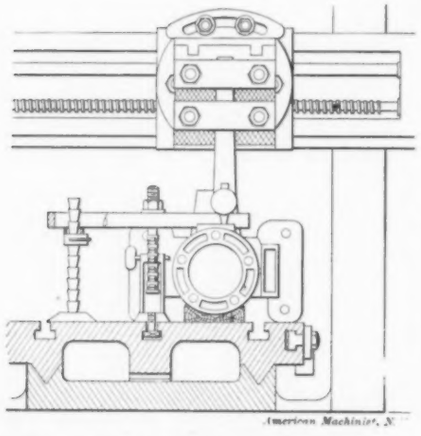



FIG. 4. T-SLOT OUTFIT AS APPLIED TO A PLANER BED

shown in Fig. 1 has a flat base and an adjustable rest, which may be set at any hight desired for supporting the end of the clamp. The form in Fig. 2 is for use on a T-slot of any machine tool. The method of locating and setting will be obvious upon an inspection of the engraving. Two applications of these bolts are illustrated in Figs. 3 and 4, which require no explanation. The manufacturers are the Red Wing Adjustable Bolt Company, Red Wing, Minn.

## Noise, Junk and Foremen

By Con Wise

Our pagan ancestors when they wanted to thoroughly scare their neighbors used to proceed to war with them, accompanied by a great noise. Whether this was more to scare the neighbors or on the principle of the small boy who whistles while he goes through the woods, I do not know; but the result was the same; power seemed to be accompanied by noise. Of late years we have been changing our ideas and now we are more impressed with the irresistibility of power if it comes in silence. We go to war as quietly as possible, we make our machinery run quietly, and we even keep the muffler on when we go automobiling.

Noise really means loss of power. It takes power to produce sound, as any man will testify who has tried to run a siren. The worst part of it is that noise itself is more of a symptom than a disease. It is an indication that something is wrong, that something is wearing itself out. A pair of noisy gears may transmit power, but they are simply grinding themselves out. A chattering tool will loose its edge before it ought. A man filing a saw will work twice as hard if the saw is poorly supported than if he has it clamped firmly. A shrieking buzz saw may mean simply that the succession of teeth striking the wood may produce an unavoidable noise, or it may mean that the whole saw table and work are set to vibrating so that more power is used than is necessary.

We are a long way from having noiseless machine shops, but I suspect that the amount of noise per dollar of output is a great deal less than it was when I first struck in. Then half the belts in the shop squealed; the planer belts we considered a necessary evil with no hope of improvement. We never expected to make money enough to get reasonably new or respectably wide belts. If anyone had suggested belts of the proportion that Taylor proposed a little while ago we would have thought him crazy. Every lathe had jaw clutches for reverse, and so it went.

### Throw Away the Junk

This reminds me of a little room we had back of the office. We had this fitted up with shelves and we used to put away things that we had no immediate use for but that we did not want to throw away. After a time the shelves were filled and we piled things on the floor. Later we filled the floor and then we stood at the door and threw things in. Father called it the "hell hole." Nowadays we try to keep the hell hole down to as small proportions as possible. It takes courage to do it.

A water faucet that cost a dollar or two brings only a few cents as scrap. If we had time we could grind the seat and put in a new leather. But the time never comes when we do it. We simply lay it one side. Finally things get so thick that we cannot find it if we want it. There is only one way out and that is to look on everything as an article of consumption and either repair it or scrap it once it needs attention.

A vise with a broken jaw laid away until another vise has a broken frame is never used; better send to the factory for a new jaw at once and put the vise into commission.

If the big monkey wrench is in need of a new screw, send over to Coes and find out whether they gave up making that pattern of wrench 10 years ago or not. If they did, scrap it.

Then get out in the shop. If there are 20 posts down through the middle it is a safe bet that there are 19 places where you can find junk that ought to be sold. Take that lathe carriage that Jim planed so thin that you are afraid to send it out on a lathe for fear the T-slots will break out. Stop saving it in case you build a lathe of your own to use. Scrap it. The T-slots might break out on a job and cost you more than a good carriage.

Look over your special tools in the tool room. There's a box of old boring-bar cutters. You are saving them to turn down for smaller sizes. Did you ever use one? Oh, yes; year before last you did find one that was just a little loose for the bar, but you used it to save it. Scrap the lot.

There is that lot of screws that you found were over size. Make a die and run over them tomorrow or else scrap them.

How about machine tools? There is that lathe, the one that Noah used when he was building the ark. You use it. Of course you do, and brag about it. Every time you have a wooden drum to turn up you turn it there. That is one day in a month. The rest of the time it stands a monument to your grandfather who bought it to save its being thrown in the junk by a man who knew where it belonged. Sell it to some antiquarian society.

Then there is that new lathe you bought last month. You needed another lathe and you were offered this one for half the price of a real one. It takes up just as much room, takes the time of just as good a man and more time, too, and a mighty

sight more for repairs than the real lathe. To be sure, the man that built it told you that if you spent the money fixing it up that you saved in buying it you would have a good lathe, but you are not in the lathe business and you will never do it. Sell it to some other sucker tomorrow unless you can find one today.

Your men in the shop? Are there any dead ones leaning up against the posts with the other junk? It is a rather hard thing to turn adrift a man that helped your father start the business, but if you are bound to support him, why not do it, but let him stay away from the shop? One man that you allow to work slowly will drag down the production of a hundred. When everybody is working hard there is no trouble getting new men to follow the pace, but nobody likes to see anyone else having a softer snap than he has. It is all very well to say that he ought to have been provident enough to look out for his old age, but we all know that mechanical skill seldom goes with financial skill. Look the country over and the men who have made a long continued success of the machine-tool business alone can be counted on your fingers. They have all been business men who associated a mechanic with them, or else mechanics who have mated up with business men. A good mechanic almost invariably needs a guardian over his earnings, and he seldom knows what he is worth or how to get it.

### Selecting a Foreman

Speaking of men, we are looking for a new foreman for the new East shop. I have a feeling that when we run across the right man we will know it, without having any rules and regulations to guide us. So far my experience has been that we have had mighty little choice in such matters. By the time we have sifted out all the material that is offered we come down to just one man that we think may do; the rest are all out of it. We never get a man without some weak spot. I imagine we never will.

A good foreman is a rare combination of skill, common sense and executive ability. In this combination skill cuts the least figure, yet no one will question but what it is desirable. The man with skill plus is apt also to be a man with common sense mines. The finest workman-made foreman, exasperates his men by showing them how much finer work can be done than they are doing. He is apt to overlook the value of time in the equation between time and quality. Executive ability is hard to define and equally hard to predict.

One of the meekest chaps that ever came to work for me is holding down a foreman's job in one of the largest shops here, and he has it just nailed down where it will stay. His case can be summed up like thousands of others. He simply impresses his men with the idea that he knows what he is doing. The average man is a sort of "follow my leader" chap. He will assert his independence every time he gets a chance to open his mouth and then turn about and follow the lead of the man who keeps his mouth shut and simply leads.

My advice to a young foreman would be: "Listen to every suggestion; keep still until you are ready to have something done and then have done just what you think best. Give credit freely to those whose advice agrees with your opinion."

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## The Irish Helper Gets the Best of the Machinist

By E. A. Dixie

Tim was a long, lean, quick-witted Liverpool Irishman who was assigned to me as helper, at Cramp's shipyard, while I had the job of coupling up the forward and after engines on the starboard side of the cruiser "New York."

Tim was very proud of his native city and while pulling the ratchet would entertain me with stories of the wonderful place, not knowing that I had been there many times. According to Tim the things that were good, the stone docks for instance, were better than anything else in the world, and the things and places which were bad, Blandford street (now out of existence) for instance, were very much worse than anything elsewhere throughout the universe.

This got to be somewhat monotonous, so one day while he was busy pulling the ratchet and I sat by, wrench in hand, to do the feeding, I said, "Tim, your last name's Hanlon, isn't it?"

"Yis, sorr."

"Well I heard a story about a Liverpool Irishman named Hanlon once, he may have been a relative of yours. The story goes this way, and proves that part of what you say about Liverpool is true.

"This Hanlon was also a machinist's helper, or laborer as they call them over there. He died and off he went straight as a dart for the gate of Heaven. St. Peter saw him coming and noticing the bit of dirty waste in his jumper pocket, he shut the door, opened the wicket, stuck his head out and said:

"'What's your name?'

"'Hanlon, sir.'

"'What's your trade?'

"'Machinist's helper, sir.'

"'Where do you come from?'

"'Liverpool, sir.'

"'Push him over the edge, Gabriel,' said St. Peter, 'we have no room for *him* here.'

"So Hanlon went down to hell and at the door was the devil who said:

"'What's your name?'

"So Hanlon thought he'd save time by giving his whole pedigree at once.

"'My name's Hanlon, machinist's helper, and I come from Liverpool.'

"'We've got no room for you here,' said the devil as he tried to close the door. But Hanlon had put his foot between the door and the jamb and shouted, 'For the love of heaven, you're not going to send me back to *Liverpool*, are you, sir?'"

"That's a good yarn, Mr. Dixie, but I heard a better wan about another Liverpool Oirishman who like me was a machinist's helper.

"His name was Hennessy and he doied, and at th' moment he doied a shootin' star was passin', so he grupped th' tail o' ut an' just as he was passin' the gate o' heaven he drops aff, stubbin' his toe agin the gate post as he 'lighted. He picks himself up and goin' over to th' dure he knocks. Afther a whoile Pether comes an' sez he:

"'Phwat's yure naame?'

"'Hinnissy, sorr.'

"'Phwat are ye to traade?'

"'Oi'm a machinist's helper, sorr.'

"'Phwere d'yez come from?'

"'From Liverpool, sorr, an' Oi'm proud o' ut,' says Hinnissy.

"'Well,' said Pether, turnin' to th' archangle Gabriel, 'Oi don't think we've got anny room for him here.' An' then he turrns to Hinnissy an sez, sez 'e, 'As ye are a hel . . . per, ye bether go to hel . . . p down below. How's thot fer a pun, Gab?'

"An' as Hinnissy turned to go, him an' Gabriel, who had drapped his flamin' sword, was a holdin' their soides an' laffin'. So down Hinnissy goes to th' gate o' hell an' peepin' troo' th' dure he sees th' divil puttin' a pint on th' ind o' his tail wid a Coates flexible grinder. An' steppin' up to ould Nick he sez:

"'Me name's Hinnissy, Oi come from Liverpool an' Oi'm a machinist's helper; is there a chanst o' a job?'

"'Sure,' sez ould Nick, 'go over t' th' stock room, open them boxes an' git the slush woiped aff them connectin' rods an' levers.'

"So Hennessy goes over an' gets a box open and then starts to look fer a bit waste or ould baggin' fer to woipe th' slush aff but he couldn't foind none. Unbeknownst t' him th' divil was watchin' him. An afther a whoile ould Nick comes over an' says kind av sarcastic:

"'Oi' hired ye as a *helper* not as a *helpless*, git on wid yer wurrk!'

"'But,' sez Hinnissy, 'Oi can't find no rags nor waste fer wipin', sorr.'

"'Is that phwat's th' mather,' sez ould Nick, 'd' yez see that ould box in th' corner? Open ut an' ye'll foind a lot av machinists in ut. They make dommed good woipin' rags; be gob, ut's all the're fit for!'"

## Dedication of the Triumph Electric Company's Oakley Plant

The first company of the colony which makes up the Oakley, Ohio, enterprise to open its doors is the Triumph Electric Company, which tendered an informal reception to its employees and friends, October 23.

The exercises were opened with an address of welcome by the mayor of Oakley, who was introduced by C. W. Moon, foreman of the small-tool department. Following this came addresses by Richard B. Fink, one of the employees, and by J. C. Hobart, manager of the company, the exercises concluding with refreshments and dancing.

The exercises were held somewhat in advance of the full operation of the works, the formal opening of which will take place later when all departments are in operation.

## Personals*

H. C. Whitehurst, with the firm of Evans, Almirall & Co., New York City, has been placed in charge of that company's new branch office at Richmond, Va.

Thurlow E. Coon, until recently connected with the Carnegie Technical Schools, of Pittsburg, has become manager of the Ball Engine Company, Detroit, Mich.

Harold L. Pope, who has been manager of the Pope Motor Car Company, Toledo, Ohio, is now acting in a similar capacity with the Matheson Motor Car Company, Wilkes-Barre, Penn.

W. S. Howe has become associated with the S. A. Woods Machine Company, Boston, Mass. Mr. Howe was formerly connected with this company, but was more recently engaged with the Canadian-Fairbanks Company, Montreal, Can.

Arthur M. Dean has recently accepted a position as assistant mechanical engineer with the Matheson Motor Car Company, Wilkes-Barre, Penn. Mr. Dean formerly held a similar position with the Mora Motor Car Company, Newark, N. J.

William E. Smith has entered the drafting department of the Babcock & Wilcox Company, Barberton, Ohio. Mr. Smith was formerly connected with the mechanical engineering department of the Delaware, Lackawanna & Western Railroad Company.

A. S. Blanchard, until recently assistant manager for receivers of the Atha Steel Casting Company, Newark, N. J., has become connected with the Birdsboro Steel Foundry and Machine Company, Birdsboro, Penn., in the capacity of assistant general manager.

*Items for this column are solicited.

## Forthcoming Meetings

American Electrochemical Society, autumn meeting, October 28 to 30, New York City. J. W. Richards, Lehigh University, South Bethlehem, Penn., secretary.

National Gas and Gasolene Engine Trades Association, Chicago, November 30, December 1 and 2. La Salle hotel. Albert Stritmatter, secretary, Cincinnati, O.

National Society for the Promotion of Industrial Education, annual convention, December 1, 2 and 3, Milwaukee, Wis. J. C. Monaghan, secretary, 20 West Forty-fourth street, New York City.

American Society of Mechanical Engineers, annual meeting, New York City, December 7-10. Calvin W. Rice, secretary, United Engineering building, New York City.

## Business Items

The Warner & Swasey Company has recently opened an office in Detroit, located in the new Ford building. Thomas Farmer, who has for several years represented the Warner & Swasey Company in the Detroit territory, will be manager of this office.

## Business Opportunities

Sandberg & Co., Freehold, N. J., will build a new shirt factory.

Aliceville (Ala.) Lumber Company will rebuild its burned plant.

New Castle Leather Company, Wilmington, Del., is erecting an addition.

Brown Bros., Bristol, Tenn., carriage manufacturers, will erect a new plant.

The Weidman Silk Dyeing Company, Riverside, N. J., will build an addition.

The Cochrane Chemical Company, Jersey City, N. J., will establish a plant.

The Jacob Dold Packing Company, Buffalo, N. Y., will build an addition.

The Winsted (Conn.) Hosiery Company is having plans drawn for an addition.

The Albion (Mich.) Malleable Iron Company will erect an aditional building.

It is reported the Canton (S. D.) Plow Company will erect a large new plant.

Means & Fulton Iron Works, Birmingham, Ala., will erect an addition to its plant.

The Pitchless Sash and Door Company, Portland, Ore., is building a new factory.

Ground has been broken for a new factory of the Utica (N. Y.) Fine Yarn Company.

The Texas Central Railroad is to build a new roundhouse at Walnut Springs, Texas.

The Reickhoff Box Company, of New Duluth, Minn., will move to South Superior, Wis.

The Buckeye Electric Company, Cleveland, Ohio, will erect a new plant to cost $75,000.

The Defiance Paper Company is preparing to erect a new plant at Niagara Falls, N. Y.

The Detroit (Mich.) Copper and Brass Company will erect an addition to its plant.

The Michigan Buggy Company, Kalamazoo, Mich., has had plans drawn for a new plant.

The American Safety Lantern Company, Glens Falls, N. Y., will erect a new factory.

North Florida Lumber Company, Line Oaks, Fla., will building a planing mill at Madison, Fla.

The W. H. Miner Coffee and Chocolate Company, Hoboken, N. J., will erect a new plant.

The Oakdale Cotton Mills, Jamestown, N. C., will erect an addition for the manufacture of twine.

The Fitchburg (Mass.) Paper Company has awarded contract for the construction of a new mill.

The Hazelhurst (Miss.) Lumber Company will erect a saw and planing mill at Covington, La.

Valentine Brothers, plow manufacturers of Minneapolis, Minn., are negotiating for a site in St. Paul.

The Dunlap Pulley Company, Tulsa, Okla., is making arrangements to establish a plant in Mexico City.

The Eastwood Wire Manufacturing Company, Belleville, N. J., has let contract for another addition.

Weidlich Bros. Company, manufacturer of silver ware, New York, will erect a plant in Bridgeport, Conn.

The Fred M. Prescott Steam Pump Company, Milwaukee, Wis., is now building another machine shop.

The Thiry & Kendrick Manufacturing Company, Detroit, Mich., will erect a new foundry building to cost $20,000.

The Burlington Lumber Company will erect a $50,000 mill at Burlington, Ore., which is a suburb of Portland.

Gade Brothers Manufacturing Company, Iowa Falls, Iowa, is building an addition to its gasolene-engine factory.

The mill of the Vernon Woolen Mills Company, at Vernon, Conn., has been destroyed by fire. Loss, about $70,000.

The Wyman & Gordon Company, Worcester, Mass., will build an addition to be used as a machine and pattern shop.

The Sangamo Electric Company, Springfield, Ill., manufacturing electric meters, will build an addition to its plant.

The Aldridge Roller Bearing Company, Brooklyn, N. Y., is negotiating for a site in New England on which to locate its plant.

The C. L. Munger Lumber Company, Elkhart, Ind., will establish a double band-saw mill in Nicholas county, W. Va., to cost $75,000.

The American Rolling Mill Company, Middletown, Ohio, has decided on plans for a new plant to cost $3,000,000, and is now considering location.

The Robert Keith Furniture and Carpet Company, Kansas City, Mo., has had plans prepared for a mattress and upholstery factory, which will cost $60,000.

The Washington Weeder Works, Walla Walla, Wash., is rebuilding its plant recently burned. New machinery, including lathe and drill presses, will be installed.

The Gifford-Wood Company, Hudson, N. Y., manufacturing conveying machinery, is having plans prepared for the construction of a new plant to cost about $100,000.

K. M. Foss, 69 Park Mansions, Albert Gate, London, England, would like price lists and particulars of ore-finding machines for locating iron, bronze, copper and silver.

Spang, Chalfant & Co., Pittsburg, Penn., manufacturing tubing, will make improvements at their plant in Etna to cost $500,000. New machine shop is being planned.

Vogel Car Manufacturing Company, St. Louis, Mo., organized with $75,000 capital, has leased a building and will equip for the manufacture of trucks and vehicles.

The Detroit (Mich.) Valve and Fitting Company will erect a plant at Wyandotte, Mich. It is said about $100,000 will be expended on building and equipment.

Plans have been prepared for the erection of a large factory for the manufacture of core compounds at West Solvay, N. Y., for the H. E. Mills Manufacturing Company.

Breeze Carbureter Company, Newark, N. J., is building a new factory for the manufacture

of carbureters, strainers, check valves, etc. Machine shop will cover 10,000 square feet.

The W. L. Holman Company, car builders, San Francisco, Cal., has consolidated with the Pacific Car and Foundry Company, and will erect a new plant at Richmond, Cal., to cost $300,000.

The American Machinery Import Office, Ltd., 24 Weinberg street, Zurich, Switzerland, would like catalogs of iron and woodworking machinery, scientific instruments, electrical supplies, etc.

The Southern Machinery and Manufacturing Company, Charlotte, N. C., a new concern, will erect a plant in North Charlotte, where all kinds of machinery will be manufactured. Thomas B. Lee is president.

The Keller Manufacturing Company, Sauk Center, Minn., whose plant was burned recently, will probably rebuild, in the meantime using its warehouse as a temporary factory. The company manufactures harrows, etc.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., November 8, for steel castings, spur wheels, steel angles, sheet steel, bar iron, sheet iron, pipe fittings, lag screws, bolts, lubricators, furnaces, bellows, copper tubing, tube expanders, stocks and dies, carborundum wheels, etc., as per Circular No. 539.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: November 2—Steel bolts (schedule 1817), drop-forged steel clamps, files (schedule 1810), twist drills (schedule 1810), hydraulic jacks, screw punches (schedule 1813), vises (schedule 1830), machinery steel (schedule 1831), round steel, nickel steel (schedule 1827); November 9—Simplex steam pumps (schedule 1837), 15-horsepower motors (schedule 1836); November 16—Screw wrenches (schedule 1825), ventilating fans (schedule 1821), sheet copper, wrought iron or steel, sheet steel, round steel (schedule 1824).

## New Incorporations

Baker Machine Company, Trenton, N. J. General machine business. Capital, $50,000. Incorporators, W. H. Baker, Israel Bates, J. L. Conard.

Sheffield Shale Tile Company, Sheffield, Ill. Manufacture brick, etc. Capital, $45,000. Incorporators, A. W. Boyden, G. N. Boyden, C. W. Boyden.

G. M. Diehl Machine Works, Peru, Ind. Manufacture metal machinery. Capital, $30,000. Incorporators, Chas. Latchene, G. M. Diehl, August Diehl.

Ellett Electric Company, Elmira, N. Y. Manufacture gas and electrical fixtures. Capital, $10,000. Incorporators, John D. Henry and Fred S. Ellett.

Bahmann Iron Works Company, Cincinnati, O. Manufacture sugar, coffee and rice machinery. Incorporators, Wm. Bahmann, E. J. Harth, R. F. Bahmann, etc.

Commercial Iron and Machinery Company, Chicago, Ill. Manufacture machinery, etc. Capital, $25,000. Incorporators, H. M. Goldsmith, J. Wexelman, W. J. Newman.

The Ironworks Company, Jersey City, N. J. Manufacture and deal in iron work and machinery. Capital, $125,000. Incorporators, B. MacLean, J. R. Palmer, C. Young.

Progress Office Specialty Company, New York. Manufacture pencil sharpeners and office supplies. Capital, $100,000. Incorporators, E. Rothschild, S. H. Meyers, L. D. Cohn.

Scott Governor Spring Company, Chicago, Ill. Manufacture metal goods, automobile and vehicle accessories. Capital, $25,000. Incorporators, G. N. Scott, F. Hardinge, A. Stubblefield.

Peru Auto Parts Manufacturing Company, Peru, Ind. Manufacture parts for automobiles and vehicles. Capital, $200,000. Incorporators, S. H. Penfield, B. S. Dean, E. D. Shearman, etc.

Western Architectural Iron Company, Chicago, Ill. Capital, $15,000. Manufacture ornamental metal work. Capital, $15,000. Incorporators, E. T. Noonan, W. F. Collins, Henry Morton.

Gervais Electric Company, New York. Manufacture electrical novelties and hardware. Capital, $110,000. Incorporators, H. Milbank, New York, R. O. Bersick, H. Martens, Brooklyn.

Ball Bearing Coupler Company, Asheville, N. C. Manufacture couplings for shafts and poles for buggies, etc. Capital, $25,000. Incorporators, W. E. Johnson, W. A. Buchanan, T. J. Cooper, etc.

Brockton Mowing Machine Cutter-Bar Company, Brockton, Mass. Manufacture general agricultural implements and machinery. Capital, $50,000. Incorporators, W. L. French, F. L. Price, etc.

Simplex Gas Engine Starter Company, Chicago, Ill. Manufacture gas-engine starters and automobile parts. Capital, $20,000. Incorporators, E. A. Gardner, C. Baldacci, Louis Funal, Adolph Funal.

Miller Metalwork Company, Jersey City, N. J. Machinists, mechanical engineers, brass founders, etc. Capital, $150,000. J. A. Miller, P. O. Miller, Jersey City; A. A. Mitchell, West New Brighton, N. Y.

The Coe-Stapley Manufacturing Company, Bridgeport, Conn. Manufacture sheet-metal goods and castings. Capital, $50,000. B. L. Coe, Waterbury, president; W. S. Stapley, Bridgeport, vice-president and general manager.

## New Catalogs

Frank Mossberg Company, Attleboro, Mass. Set of illustrations of wrenches actual size.

United States Alloys Company, 1206 American building, Baltimore, Md. Circular of metals, alloys and fluxes.

Utica Drop Forge and Tool Company, Utica, N. Y. Catalog describing nippers and pliers. Illustrated, 46 pages, 6x9 inches, paper.

The Miami Valley Machine Tool Company, Dayton, Ohio. Catalog F, describing grinders, lathes and drills. Illustrated, 9x11 inches, paper.

Wells Bros. Company, Greenfield, Mass. Booklet describing die holders for use on screw machines. Illustrated, 16 pages, 5x7½ inches.

Norton Company, Worcester, Mass. Booklet entitled, "Facts Worth Knowing about Grinding Wheels." Illustrated, 12 pages, 3½x6 inches.

The Standard Machinery Company, Mystic, Conn. Pamphlet describing Coit's Twentieth Century ball-bearing drill chuck. Illustrated, 8 pages, 6x8 inches.

The Atlas Machine Company, Waterbury, Conn. Catalog of edging, nurling and trimming lathes, power presses, etc. Illustrated, 30 pages, 6x9 inches, paper.

Smooth-On Manufacturing Company, Jersey City, N. J. Instruction Book No. 8 on iron cements, sheet packings, etc. Illustrated, 94 pages, 4½x6½ inches, paper.

Davis-Bournonville Company, 90 West street, New York. Catalog of oxy-acetylene welding and cutting apparatus. Illustrated, 32 pages, 6½x10 inches, paper.

Reliance Electric and Engineering Company, Cleveland, Ohio. Bulletin No. 101, showing application of Lincoln motors to shapers. 16 pages, 8x10½ inches.

The Skinner Chuck Company, New Britain, Conn. 1909 catalog and price list of lathe, drill and planer, chucks, press vises, etc. Illustrated, 48 pages, 4x7 inches, paper.

New Jersey Foundry and Machine Company, 90 West street, New York. Catalog 77, describing tracking, trolleys, hoists, cranes, etc. Illustrated, 96 pages, 6x9 inches, paper.

American Watch Tool Company, Waltham, Mass. Catalog of precision bench lathes, bench drills, pinion cutters, filing machines, milling machines, etc. Illustrated, 88 pages, 6x9 inches, paper.

F. E. Wells & Son Co., Greenfield, Mass. Machinery Catalog No. 7, describing speed lathes, chucking lathes, screw machines, cutter and reamer grinders, plain cutter grinders, centering machines, tapping and threading machines, etc. Illustrated, 40 pages, 6x9 inches, paper.

# Want Advertisements

*Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.*

## Miscellaneous Wants

Caliper catalog free. E. G. Smith, Columbia, Pa.

We solicit your representation. Maxant & Company, 222 So. Canal St., Chicago, Ill.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Fine, experimental work and tool designing and making a specialty. Benj. O. Butler, Taunton, Mass.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emery & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Arthur C. Mason, designing engineer, drafting, special machinery developed, inventions perfected; 227 Canal St., New York City.

Metal specialties manufactured, models, dies and special machinery; inventions perfected. Villinger Mfg. Co., Williamsport, Pa.

Wanted—Purchaser for No. 2 Farwell milling machine, Grant hobbing machine and Gisholt tool grinder; all practically new and in A-1 condition. Box 755, AMER. MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Machinists and engineers blueprint chart of United States Standard pipes and tapping sizes from ¼" to 10" pipe. Price 10 cents per copy postpaid. Liberal discounts to shop

agents. Address Charles Kuderer, Woodlawn, Penn.

## Situations Wanted

*Classification indicates present address of advertiser, nothing else.*

CONNECTICUT

Mechanical draftsman wishes position; experience on engines and electrical apparatus; also shop experience. Box 813, AM. MACH.

Experienced superintendent, now employed, open for engagement; large experience in manufacturing small or medium interchangeable work; good reliable mechanic with executive ability; thorough experience in modern shop methods. Box 819, AMER. MACH.

Factory manager or superintendent; have had 20 years' experience in the manufacturing of steel, brass or bronze balls, having invented most of the machinery now being used in the country; also 10 years' knowledge in the manufacture of ball and roller bearings, such as annulars, ball, plain and taper roller thrusts, in fact, every kind of bearing up to five feet in diameter; reference; East preferred. Box 811, AMERICAN MACHINIST.

ILLINOIS

Mechanical engineer, factory systematizer and cost accounting; experienced in electrical apparatus, gas engines, machine and tool building; have served both as chief draftsman and superintendent; wide knowledge of practical shop methods; can furnish best of references from men well known in the mechanical world; open for position as superintendent or master mechanic; age 39. Address "Designer," 321 St. John's Court, Chicago.

MASSACHUSETTS

Factory superintendent at present engaged, wishes to make a new connection, preferably New England States; technical education as mechanical engineer; 18 years' manufacturing experience on automobiles, guns, sewing machines, special machinery and similar work. Box 798, AMERICAN MACHINIST.

NEW JERSEY

Technical graduate, with five years' experience on general machinery, printing press and automatic machine design. Box 827, AM. MA.

Office executive, 33, thoroughly trained, seeks responsible position; 15 years' machine manufacturing experience; master of all office details; excellent correspondent, experienced advertiser, good executive ability and a hustler; references the best; salary, $1200. Box 815, AMERICAN MACHINIST.

NEW YORK

Draftsman, mechanical, all-round man, reliable, accurate, wants steady position. Box 820, AMERICAN MACHINIST.

Wanted—Position as tool designer; capable of taking charge; references from leading automobile concerns. Box 830, AMER. MACH.

Wanted—By young machinist and technical graduate, position as calculator and junior draftsman; steam or gas engine work preferred. "E. S.," Box 829, AMER. MACHINIST.

Mechanical engineer and designer, seven years' practical experience in drafting room and shop; wants position offering a future; good references. "H. L.," Box 831, AM. MA.

Specialist on crude oil engines of highest known economy desires position of full responsibility, in which reliable designs and modern production and sales engineering can help earning dividends. Box 824, AM. MACH.

Practical machinist; inventive turn of mind; understands steam, electricity, hydraulics; can build or repair engines, tools, machinery of any description; desire situation for upkeep of factory, shop or mill. Box 828, AMERICAN MACHINIST.

Superintendent, now employed, wants to change; adding machines, typewriters, firearms, electrical instruments, or a similar line of manufacturing of small or medium interchangeable work; broad experience as foreman and superintendent. Box 825, AMER. MACH.

Salesman—Machine tool salesman as sales manager, having 15 years' experience, both in the manufacture and selling of machine tools; competent judge of condition and value of second-hand, and familiar with all makes in the United States; can give best of reference. Box 790, AMERICAN MACHINIST.

Mechanical engineer of established reputation; wide and extensive experience as designer, chief draftsman, superintendent and mechanical engineer with prominent concerns building intricate automatic and special machinery; able to see things wrong and capable to make them right; propositions desired from large, progressive concerns, who consider a reliable, capable and energetic man of highest standing worth his money. Box 826, AMERICAN MACHINIST.

PENNSYLVANIA

Mechanical engineer, technical college graduate, twelve years' experience machinery manufacturing business, both in office and shop, desires position with company of high standing. Box 817, AMERICAN MACHINIST.

Experienced mechanical engineer, American, age 36, would like to hear from progressive manufacturing company, looking for moderate additional capital to enlarge business, which can utilize services of advertiser to advantage. Box 816, AMERICAN MACHINIST.

## Help Wanted

*Classification indicates present address of advertiser, nothing else.*

CONNECTICUT

Wanted—Experienced mechanical draftsmen for detail work, in a concern manufacturing general rolling mill and hydraulic machinery; state age, experience and salary expected. Box 796, AMERICAN MACHINIST.

ILLINOIS

Wanted—Superintendent and works manager; high-grade man capable of organizing new department of old established company, purchasing new machinery, installing cost system and up-to-date system of manufacture; product similar to automobile work; working force about 800 men. Write experience fully, stating when interview can be had. Box 818, AMERICAN MACHINIST.

KENTUCKY

Wanted—A man who can act as foreman in machine shop doing specialty work; must be capable of managing men so as to bring out their maximum capacity; none except competent and very energetic men need apply; shop non-union; past and present references required. Box 789, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—First-class draftsmen. Apply Supervisor of Drafting Rooms, General Electric Company, Pittsfield, Mass.

Draftsman wanted—First-class, thoroughly experienced mechanical draftsman; steady position if satisfactory. Box 814, AM. MACH.

Wanted—An expert draftsman, capable of designing jigs and fixtures for the manufacture of small tools, etc. The L. S. Starrett Co., Athol, Mass.

Wanted—Capable executive to take charge of rate setters in engine works; must be experienced in determining piece rates, both directly and indirectly, from analytical time study observations; state age, experience and pay expected; correspondence confidential. Ad. "R. S. D.," P. O. Box 167, Boston, Mass.

Wanted—Competent man to take charge of tap threading department, also foreman for inspection department. Apply, with references, Wells Brothers Co., Greenfield, Mass.

Wanted—Sheet steel salesman for New England territory; good position for young man who has thorough knowledge of various qualities and finishes of soft steel sheets and strips. Address Wheelock, Lovejoy & Co., Boston, Mass.

Rate Setters Wanted—Must have had experience with time study method, using stop watches; opportunities for advancement in Massachusetts plant building engines, marine specialties, etc.; state age, experience and salary expected. "R. S.," 24, Box 167, Boston, Mass.

MICHIGAN

Two first-class gear men wanted for day or night work; state age, experience and wages. Buick Motor Co., Flint, Mich.

Wanted—Men with first-class experience on Brown & Sharpe and Acme automatic screw machine; none but first-class men need apply. Box 740, AMERICAN MACHINIST.

Wanted at once, toolmakers, die sinkers, trimming diemakers, machinists, automatic screw machine hands; state age, experience, customary wages and references. Buick Motor Company, Flint, Mich.

Wanted—Semi-executive connection with firm building general, medium and heavy machinery; successful designer; 32 years of age; good reasons for desiring change; clean record; best reference. Box 809, AMER. MACH.

Wanted—An expert screw-machine operator to take the position of assistant foreman in a department of about fifty machines consisting of Jones & Lamson's, Acme automatic, Gridley and Cleveland automatic. Box 775, AMERICAN MACHINIST.

MISSOURI

Foreman diemaker, experienced on sheet metal dies of all descriptions. Swaine Co., St. Louis, Mo.

Draftsman wanted who is thoroughly familiar with machine design and experienced in drafting room and shop practice. Curtis & Co. Mfg. Co., St. Louis, Mo.

Mechanical engineer for sales department wanted who has engineering and sales experience in successful manufacturing establishment. Curtis & Co. Mfg. Co., St. Louis, Mo.

NEW HAMPSHIRE

Wanted—A first-class machinist for setting up and assembling machine tools; opportunity for advancement to man with experience on similar work and capable of handling men; give age, experience and wages expected. Box 743, AMERICAN MACHINIST.

NEW JERSEY

Tool draftsman wanted; must be man well up on tools for small duplicate work; state experience and wages expected; also age and references. Box 808, AMERICAN MACHINIST.

NEW YORK

Wanted—A draftsman on power pump work; give reference, age and salary desired. Box 785, AMERICAN MACHINIST.

First-class Gisholt turret lathe operators; men who can design and make tools, also run the lathes. Box 821, AMERICAN MACHINIST.

Wanted—Draftsman familiar with design and construction of steam hammers. Write giving references and stating salary expected. Box 784, AMERICAN MACHINIST.

Wanted—Machinists, toolmakers, lathe hands, screw-machine hands, milling-machine hands and motor assemblers; steady position to desirable characters. Maxwell-Briscoe Motor Co., Tarrytown, N. Y.

OHIO

Wanted—Manager, who can obtain some capital, for modern machine works, running day and night, located in Ohio. "Engineers," Box 759, AMERICAN MACHINIST.

Wanted—Several first-class draftsmen thoroughly familiar with designing steam hammers. In applying state age, experience and salary desired. Box 791, AMER. MACHINIST.

Wanted—A high-class, experienced foreman for sheet and steel department of a large stove foundry, desired from January 1 next; give references, experience and wages desired. Address "Morning Star," AM. MACH.

Wanted—First-class lathe, shaper and boring mill men accustomed to accurate work, for day and night shift; state age, experience and wages expected; no labor trouble; increasing force. The Heisler Company, St. Marys, Ohio.

Toolmaker Wanted—Specialist in making form tools and cutters as used in the line of watch case manufacturing; must be familiar with the use of heat-treatment of high-speed steel; wages $3.50 per day to start with. Address H. Detmering, Supt., The Dueber Watch Case Mfg. Co., Canton, O.

Superintendent; progressive manufacturer, having foundry, pattern and machine shops employing 500 men, needs a thoroughly experienced and systematic superintendent; machine shop and foundry experience essential; give full details, past and present record, naming employers; communications strictly confidential; only men with a record need apply. Box 688, AMERICAN MACHINIST.

Wanted — First-class machinists, lathe, planer, brass molders, drill press, screw machine boring and milling machine operators, die sinkers and patternmakers who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Building, Cleveland, O.

PENNSYLVANIA

Wanted—Good automobile and tool draftsmen; also tracers. Apply Chief Draftsman, Matheson Motor Car Company, Wilkes-Barre, Penn.

Wanted—First-class draftsman, familiar with engine and boiler layouts and designing; steady employment. Address P. O. Box 512, Erie, Penn.

Draftsman for mathematical and optical instrument work. Address, stating training and experience, Commanding Officer, Frankford Arsenal, Philadelphia.

Wanted—Young man as steam engine salesman; only replies giving full details of past experience, training and remuneration will receive consideration; all replies confidential. Box 783, AMERICAN MACHINIST.

Wanted for modern machine shop, first-class man to operate Gleason bevel gear planers; also man for spur gear cutting machines; only those that can produce results need apply; good chance for advancement. Box 812, AMERICAN MACHINIST.

Foundry foreman wanted; must be young, energetic, a good executive and accustomed to modern methods; a man who can qualify as working foreman will be given full charge as soon as ability is proven; location, central Pennsylvania. Address, with full details as to experience, wages and references, Box 810, AMERICAN MACHINIST.

Wanted—A good live agent in every shop or factory in the U. S. to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and above his regular salary. This is no fake. Write for free sample and agents' terms. The Klenzola Co., Erie, Pa.